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ABSTRACT

This resource guide presents Design Determinants and Options to be used by designers, school district personnel, and State officials in the programing and design of small rural secondary schools in the Alaska bush. The vast and unconventional educational and space planning challenge is compounded by: the need to provide most or all of the utilities; inappropriate technology; difficult logistics for construction, maintenance, and operation; and a harsh natural environment. Three Design Determinants--major groups of critical factors that affect facility programing and design--are Building Program Determinants (facility use, for what purpose, by whom and how many, maintenance skills level, fire and life safety, etc.), Environmental Determinants (climate, geotechnical and hydrological factors, logistics), and Site Utilities Determinants (water, waste disposal, electricity). Design Options are systems, elements, and concepts selected by a designer and based on Design Determinant information gathered prior to programing. These options refer to building safety and health requirements; site utilities; siting of buildings; building envelope, structure, and utilities; and building programs for secondary schools, in which detailed options are given for facilities for 4 separate enrollment groups as defined by the Department of Education: 10 or fewer, 11 to 20, 21 to 32, and 33 to 46. (SB)

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I. Design Determinants and Options

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State of Alaska
Rural Schools Prototype Analysis

prepared by CSM INC

RC 011 286

Mc 07-05-79

VOLUME I, DESIGN DETERMINANTS AND OPTIONS

Rural Schools Prototype Analysis

Prepared For:

State of Alaska
Department of Transportation and Public Facilities
Division of Facility Procurement Policy

8/1/78

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PREFACE

HISTORY:

The State of Alaska is charged with providing a great number of rural secondary schools during the next few years. The Department of Transportation and Public Facilities identified the need to assemble and analyze solutions for the design of these new schools. In April, CSM was retained to begin work on this report entitled, "Rural Schools Prototype Analysis." We met many times with a working group of school district people and DOTPF-DOE staff. This report was prepared on the basis of information gathered in these meetings, by travel to numerous village sites, and from our previous rural school experience.

THE PROBLEM:

Rural schools in remote Alaskan communities presents challenges that cannot adequately be solved with conventional design experience and current technology. Designing a rural Alaskan school, and designing a conventional school building are problems vastly different, both in their problem-solving process and product. A secondary school with 23 students taught by two teachers requires different teaching techniques than a school of 800 students taught by 30 teachers. Two teachers offering the full range of high school curriculum to 23 students is an immense educational and space planning challenge. Teaching in this situation is an unconventional problem, and the problem is compounded when the following conditions are considered: 1) providing most or all utilities; 2) coping with inappropriate technology; 3) difficult logistics for construction, maintenance, and operation; and 4) a harsh natural environment. The solution becomes complex and unique to each individual village.

THE REPORT:

This report addresses a design process and solutions for the challenge at hand. It is important to understand that our report is only a part of the total process that results in a new school. We have identified some planning aids and concepts that transcend normal building design in an attempt to relate the design process with the overall facility procurement process.

Three volumes comprise the entire report:

VOLUME I, DESIGN DETERMINANTS AND OPTIONS

VOLUME II, METHODOLOGY

VOLUME III, FIELD DATA

Volume I, containing Design Determinants and Options, is the primary product of the report. Design Determinants describes information that needs to be gathered when beginning facility programming and design. Design Options are systems, elements, and concepts that are selected by a designer based upon the information contained within the Design Determinants.

Volume II illustrates a Methodology for applying Volume I to an example project. Volume III has been printed in limited numbers and will be used by the State as a record of Field Data that evaluted performance of existing facilities.

SYNOPSIS:

We haven't composed a miraculous cure for all the ills of Alaskan rural school architecture.

We have, however, presented a resource guide that can be used by designers, school district personnel, and State administrators.

Perhaps anticipation is the cornerstone of this report. These schools, good or bad, will be with us for a long, long time. The more time and attention paid to every possibility that we can anticipate, the less we are going to have to look back on what we have done and regret a lack of foresight. After all, if we do not have the time, or the money, or the will to do things right in the first place, how will be ever find the time, or money, or the will to do them over again?

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SECTION 1.0 BUILDING PROGRAM DETERMINANTS

INTRODUCTION:

Design of a school in bush Alaska is not limited to the design of a simple building enclosure with classrooms and a multipurpose room. Utility connections do not occur five feet from the face of the building, as they would in an urban condition. The facility may be called a school, but in reality it is often a self-sufficient community facility with requirements for operating and maintaining its own utility systems in addition to providing an educational program.

The objective of BUILDING PROGRAM DETERMINANTS is to present a format for gathering critical information that must be considered by the owner, the State, or the architect in order to adequately determine the scope of the project and allow for the proper coordination and decisions to be made before initiating the design process. Designing a bush school is in many respects comparable to putting together a jigsaw puzzle, and identifying the critical determinants is analogous to identifying all of the pieces that must fit together.

BUILDING PROGRAM DETERMINANTS addresses the following questions that should be initially identified: how is the facility to be used; for what purposes; by how many people; by what kinds of people; what will be the level of community use; how skilled is the maintenance staff; who will build the facility; should the facility be planned for expansion (and what are the priorities for this); what existing facilities and utilities can be utilized; should the facility be temporary or permanent; what are the concerns for fire protection, insurance savings, freeze protection, emergency power generation?

BUILDING PROGRAM DETERMINANTS are identified and a statement of consideration is given to explain why each particular determinant is important to the facility design. An open-ended CHECKLIST included in VOLUME II, METHODOLOGY, allows the school district, State, or architect to identify specific determinants as they apply to the given situation.

1.1 UTILIZATION:

1.11 Enrollment:

Considerations:

1. Size of Facility: The size of the facility in gross square footage is allocated by DOE space guidelines based on projected enrollment. The design enrollment may be based on the projected enrollment five years after completion of the facility. Taking into account that design and construction will take two to three years, planning must project seven to eight years into the future. The target design population would presently be attending elementary school. Factors must be included for immigration, drop-out rate, and potential accommodation of nearby villages or resource development bases.

2. Limitation to Educational Program: The size of the enrollment group will place limits on the extent and the character of the educational program that can be realistically offered. The enrollment will also influence the number of teachers, aides, and support personnel required to operate the program and facility.

3. Operations Cost: The early projection of enrollment, staff, and the magnitude of facility can allow the school district to project operations costs. This early projection will allow for adjustments in program to meet economic constraints before proceeding into the design phase.

1.12 Staffing:

Considerations:

1. Housing: The staffing requirments will determine the need for additional teacher housing which will also increase the demand for utilities and may increase school enrollment if the teachers have children.

2. Teacher Stations and Student/Teacher Ratio: The size of the staff will determine the minimum number of teaching stations to be designed for, as well as influencing the size of student groups and the student/teacher ratio.

3. Maximize Utilization of Personnel: Knowledge of schools' staffing plan not only includes the number of teachers and aides, but also an insight to their responsibilities and how they will interrelate to structure and secondary program; of course, this will vary from year-to-year depending on the skills of the individual teacher. In any case, there is shared or delegated responsibility for teaching, counciling, administering the educational program, and administering the physical plant. With a limited number of teachers, a design objective is to create a plan which allows for the most efficient use of personnel. In the small high school, an individualized learning program allows for not only the treatest range of program offerings, but is also more responsive to individual needs. Major design trade-offs occur between the need for supervision and acoustical separation. It is difficult to hold class next to a shop where someone is using the power saw. Scheduling of classes becomes an integral part of designing floor plans.

1.13 Conceptual Teaching Patterns:

Considerations:

Traditional versus Open-plan: The conceptual teaching patterns will affect the design in terms of the balance between traditional (fixed) classrooms and multipurpose (open/flexible) classroom space. The trade-offs between increasing the size of the multipurpose room, by using a portion of the room for academic space versus having a smaller multipurpose room and traditional teaching areas, must be evaluated early in the programming phase.

1.14 Educational Specification:

Considerations:

The educational specification as developed by, or for, individual school districts and villages should address enrollment, staffing, and teaching patterns, and also provide the basis for planning spaces to accommodate the specified educational goals, subject areas, activities, space requirements, and equipment of those districts. The information provided in Section 4.0, Building Program Options, may be used as a reference guide or point of departure. The educational specification will allow the school districts to tailor their facilities to meet local educational priorities. This will be extremely helpful to the designer in allocating space among competing program areas.

1.15 Integration with Existing Educational Facilities and Program:

Considerations:

While this document is primarily aimed at the design of secondary schools, in most villages where a seconary school is to be constructed, an elementary school will already exist. The total combined use of both facilities needs to be considered. If a multipurpose room is built as a part of the secondary school and none exists in the elementary school, it might be assumed that the new facility will receive dual use. If a kitchen exists in the elementary school, it may accommodate the secondary school food service program without constructing that space in the new school. The programmed dual usage of facilities would have a dramatic effect on site selection, building location, orientation, and type of construction.

1.16 Context of School in Community:

Considerations:

1. Scale: In scale, the school will undoubtedly be the largest building in the village. The need for an energy efficient and economical facility will influence the design of building with a minimum of exterior surface area. The transition of the building to human scale should be accomplished in the design of the entries.

2. Character: The character of the building as it is perceived by the local residents will be influenced by the selection of buidling materials (types and quality), shapes, details, color, and the building's design response to local site conditions.

3. Accessibility: The accessibility of the facility is determined by its general location within the village, the orientation of entries to existing paths and roads, the relationship of the school to adjacent buildings and topography, and the design of entries that are not obstructed by environmental conditions or made perilous by melting ice and snow.

4. Community Use: The projected use of the educational facility by the community must be considered in the initial programming phase. This information can influence the design to control accessibility of certain parts of the facility for management use; to allow for the design of flexible spaces to accommodate various community activities; to determine the specification of higher quality materials and finishes to withstand increased wear; and to affect sanitation requirements and sizing of utility systems for increased capacity due to 9 versus 12 months, and 8 versus 24 hours of operation. Operating costs for maintenance and operation should also be projected given the desired plan of operation.

1.17 Maintenance Technology:

Considerations:

1. Skill Level of Maintenance and Operations Personnel: In many instances, the skill level of existing maintenance and operations personnel within the village must be determined to plan for a building systems design that can be maintained by local personnel. If more sophisticated building systems are required by the school district, building program, or codes, then planning for additional training of existing personnel or acquisition of new personnel must be carried out. Such considerations might determine the selection of a furnace versus a boiler, for example.

a. Water Systems: The technological level of the villages is probably the most critical determinant that is not caused by natural conditions. More systems in villages of Western Alaska have probably failed due to a lack of understanding of the ability of the persons that actually monitor and operate the system than to any other force involved. Careful evaluation of the technological capabilities of the village, the response of the people themselves as to their needs and desires, and to the potential maintenance problems that may occur must be addressed before design is undertaken.

The "kiss" principle* (*Keep it Simple!) is often claimed, but not often followed when designing water systems for the villages. An evaluation by the designer as to the general overall character of the village can be established by visual inspection of existing facilities. Those villages which exhibit a high technological level will be evident by well-maintained buildings, good control of garbage and debris, and active participation in the selection of whatever system is proposed. Those villages with a high incidence of failure will be exhibited by the inverse; buildings will not be maintained and people will not have an interest in the proposed facility.

Operation and maintenance of any designed facility that is placed into a village requires maintenance training for personnel. Identification of the training required and a training program that is ongoing, regardless of who may be in the village, is necessary for satisfactory operation of any water system.

b. Waste Water Systems: The technological level, as stated above in the discussion of fresh water supply systems, is the most critical determinant for proper operation and maintenance of a waste water system. While control of an on-site septic system or lagoon system does not require a high level of technology, the use of packaged treatment plants, either biological or physical-chemical, requires expertise and constant monitoring. This level of expertise and monitoring must be provided by the operator if the system is to succeed in its function as a waste water treatment facility.

2. Design Trade-offs: Planning for maintenance and operation must coincide with initial programming and conceptual design. Trade-offs between simplicity, energy conservation, frequency of maintenance, manual versus automatic operation, first cost versus life cost, code compliance, and performance level must be addressed and given their proper priorities by the owner and A/E at the earliest possible date.

1.18 Future Expansion:

Considerations:

1. Site Planning: The initial site planning must consider where expansion is to occur and recognize topography, soils, property lines, and distances to adjacent buildings. (See Section 7.1).

2. Location and Size of Areas to be Expanded: Provisions must be made in initial design for expansion of mechanical and plumbing systems to accommodate growth. If a multipurpose room is to be enlarged to a full size gym, the original plan and structural design should take this into account.

3. Roof Slopes: Where pitched roofs are used, the slope of the roofs will determine where expansion can occur.

4. Sizing of Utility Systems: The initial sizing of utility systems to accommodate future expansion will, in many cases, amortize the additional first cost. The sizing of water, sewer, power, and fuel utilities is many times incorrect when planning and budgeting for future expansion is not considered.

5. Circulation Spines: Expansion must include provisions for extending corridors as required to provide access to existing and future program areas.

6. Strategy: One strategy the school district may utilize to adequately plan for expansion is to contract the A/E to masterplan the facility as a part of the schematic design phase, making certain that all building and site utilities are included in the masterplanning effort. Then the school district may proceed into design development and working drawings for the portion of the facility estimated to fall within the projected budget. (See Section 7.1).

1.19 Design Life:

Considerations:

1. Term of Projected Use by Owner: The determination of the term of use by the owner will influence the designed maintenance and fire-resistive characteristics of the building and the quality of finish materials and utility systems; in some cases, it will also influence the skill level required to construct the facility based on the level of technology being utilized (e.g., metal vs. wood).

2. People's Perception of Facility: The perception of the quality and permanence of the facility will influence user attitudes (e.g., is facility temporary or permanent?). People have more respect for permanent facilities than temporary structures. The inherent quality of the facility will influence the acceptance of the institution as a symbol within the community.

1.20 Design for the Handicapped:

Considerations:

1. Code Compliance: Compliance with handicap design standards is required to receive Federal funding. The design standard to be used by the A/E must be verified with the State.

2. Design Applicability: Design for the handicapped will affect the following areas according to requirements satisfying a specified range of disabilities:

   a. Site access.
   b. Site/building access.
   c. Interior circulation, maneuvering room.
   d. Interior level changes.
   e. Vertical circulation.
   f. Door swings.
   g. Height of controls and switches.
   h. Type of control activators.
   i. Furnishings.
   j. Communications equipment.
   k. Life/safety equipment.
   l. Identification devices.
   m. Hazard protections.
   n. Surface textures.
   o. Handrails.

3. Major Design Adaptions: In general, facilities should be designed to allow the handicapped to participate in all programs as determined by the extent of their disability. To the facility planner this means providing barrier-free access from grade level to the entrance and providing interior access to all program areas, except in instances where a program offered on an upper level of a facility is also offered in an accessible area. Ramps, toilets, showers, and clearances are elements of primary concern to the designer in the conceptual planning and design phases. These items only become burdensome or awkward if they are considered as an afterthought and not integrated into the total design concept. For instance, most bush schools are elevated above grade for various environmental reasons; if integrated into the design, the handicap ramp may serve as the major entryway to the building.

By accommodating the handicap requirement, the ramp may also serve as good access for the delivery of supplies, and it may double as an access to the shop area. Besides, a long ramp with a grate surface does a good job of cleaning snow and grit from shoes, which will decrease maintenance and increase the life of floor surfaces. Additional information for space planning of ramps, toilets, and showers is given below:

HANDICAP DESIGN INFORMATION

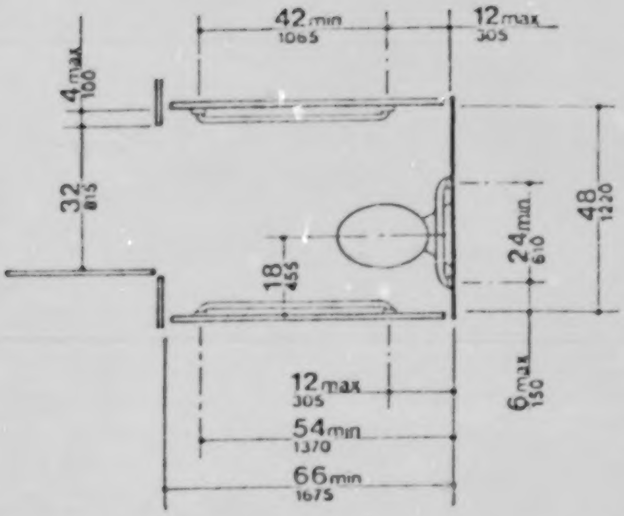
Table — Maximum Lengths and Slopes Allowed for Ramps

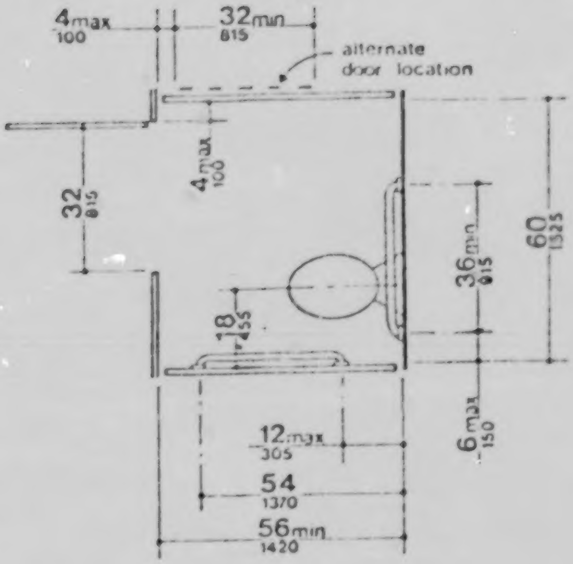
Maximum Horizontal Projection for Rampways a	Maximum Horizontal Of Projection Each Run	Maximum Rise of a Single Run	Allowable Slope Percent of Slope and Ratio (in parentheses) b.
2' (0.6 m)	2' (0.6 m)	3" (75 mm)	If Slope = 12.5% (1:8) or less steep c.
8' (2 m)	8' (2 m)	9" (230 mm)	If Slope = 10.0% (1:10) or less steep
60' (18 m)	30' (9 m)	30" (760 mm)	If Slope = 8.3% (1:12) or less steep
160' (49 m)	40' (12 m)	30" (760 mm)	If Slope = 6.25% (1:16) or less steep

a. A rampway may have more than one ramp run; landings are not counted as part of total maximum horizontal projection.

b. All slopes taken from a horizontal (level) plane.

c. Where curb ramps intersect streets or walks that have severe opposite slopes, this slope (1:8) may not provide enough clearance for wheelchair footrests at the bottom of the ramp.


42 min
1065
12 max
305
4 max
100
32
815
18
455
24 min
610
48
1220
12 max
305
6 max
150
54 min
1370
66 min
1675

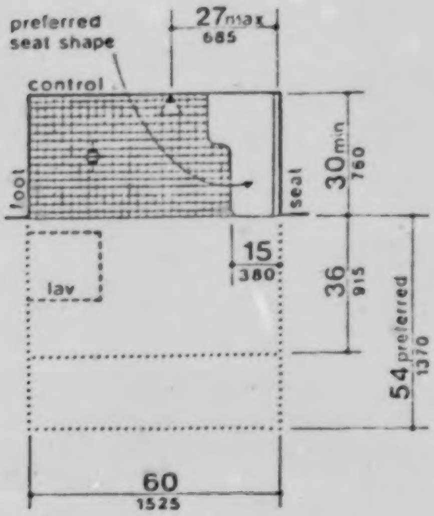

4 max
100
32 min
815
alternate
door location
32
815
4 max
100
36 min
915
60
1525
18
455
12 max
305
6 max
150
54
1370
56 min
1420

NOTES: Add 3 in. to the minimum depth of a stall if floor mounted toilets are used. See 7.3.1 for location of flush controls.

A. Type A Plan

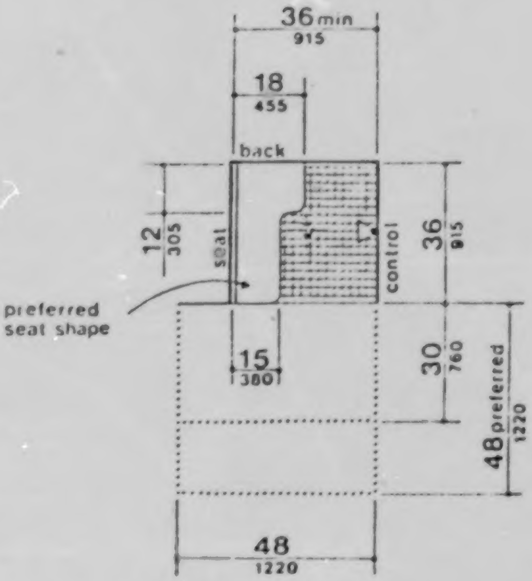
B. Type B Plan

Toilets


preferred
seat shape
27 max
685
control
foot
seat
30 min
760
15
380
lav
36
915
54 preferred
1370
60
1525

Minimum Dimensions and Clearances

Five-Foot Wide
Shower Stall


36 min
915
18
455
back
12
305
seat
control
36
915
preferred
seat shape
15
380
30
760
48 preferred
1220
48
1220

Minimum Dimensions and Clearances

Three-Foot Wide Shower Stall

FIGURE 1.1: HANDICAP DESIGN STANDARDS (FROM: PROPOSED ANSI A 117.1 1977)

1.2 BUILDING SAFETY: A school facility represents a multimillion dollar investment and several years of planning, design, and construction. The loss of a school facility means not only a loss of time and money, but a major disruption of the educational program for up to several years while funding and reconstruction are undertaken. This can be particularly critical in rural locations where frequently suitable, temporary space is not available. The most serious potential hazards to a rural school facility are fire, freezing, flooding, and vandalism.

1.21 Fire Protection: Many villages do not have any public firefighting equipment, so the school facility should be designed to minimize or suppress potential fire hazards within the structure and surrounding the structure. (See Section 5.2).

1.211 Extinguishing Systems: Extinguishing systems should be considered for hazardous areas such as shops, kitchens, furnace rooms, and generator facilities. Extinguishing systems may be manually or automatically activated, using water or chemicals, depending on the hazard type and location. Typically, fire extinguishing equipment may consist of portable fire extinguishers, fire hoses, wet or dry sprinkler systems (see Section 5.251), or Halon chemical extinguishing systems. Selection of a system(s) will depend on available water source, appropriate fire and building codes (dealing with occupancy and type of construction, see Section 5.4), exposure of fire suppression equipment to freezing, maintenance requirements, and budget.

1.212 Fire Alarms: Fire alarms are intended to notify occupants of a building and vicinity of a fire hazard in order to evacuate the facility and to begin fire suppressing operations. Fire alarms may be manually or automatically activated (see Section 5.22, and 5.23). Fire bells, horns, and lights should be located both inside and outside the structure, and possibly located in school staff quarters. Battery or emergency power should be provided for all fire alarm systems.

1.213 Building Materials: Use of noncombustible or fire-retardant materials can minimize losses due to fire, and may be required by codes for certain occupancies and construction types (see Section 5.251).

1.214 Building Location: Wind-borne fire hazards, to and from other adjacent buildings and equipment, should be considered.

1.22 Freeze-up Protection: Power failures in rural locations are common. Even with emergency power back-up equipment, the potential for a power outage or furnace failure is still high. Most school heating systems cannot operate without power. Without a heating system, there is serious potential for freeze-up of both plumbing and fire suppression equipment. All plumbing systems within a facility should be designed for easy drainage in case of freeze-up. (See Section 5.3).

1.23 Flood Protection: In locations where flood hazards have been identified, consideration must be given to protection of the building by raising it above flood level or constructing dikes around it. Consideration must be given to protection of site utilities and amenities such as walks, decks, and roads in areas which suffer from frequent flooding. (See Section 2.22).

1.24 Vandal Protection: Consideration must be given to minimizing potential vandalism. The owner must establish priorities of items to be considered. These priorities are based on known or anticipated vandalism, and budgeting available to respond to vandalism. (See Section 5.1).

1.241 Site Location: The location of the site determines, to some extent, the amount of vandal protection required. Facilities that are remote from the village will experience more vandalism.

1.242 Owner's Perceptions: The owner, school board, and staff can assist in determining guidelines for considering vandal options.

1.243 Budget: Vandal protection is often a product of the initial construction budget. Life-cost of materials and equipment must be considered when designing a facility.

1.3 LIFE SAFETY: Of paramount importance in the design of a school facility is the safety of occupants. The most serious occupant hazard is fire. A building must be designed to minimize fire potential, and safe egress must be provided at all times under all weather conditions for occupants in case of an emergency. (See also Section 5.4).

1.31 Fire Protection:

1.311 Extinguishing Systems: Sprinkler systems can provide additional safety for occupants.

1.312 Fire Alarm Systems: Fire alarm systems, whether automatic or manual, should be designed with both audio and visual signaling devices.

1.313 Building Materials: Use of low-smoke contributing, fire-retardant, and noncombustible materials should be considered wherever possible.

1.314 Exiting: Drifting snow can block doors shut, creating a serious life safety exiting problem. Building codes establish minimums for exiting requirements, and designing optimum exiting from a building is an important determinant that may exceed code minimums.

1.4 BUDGET:

Considerations:

1. General:

Budgets are always speculative, but the accuracy of the budget projection may be analyzed according to how well the scope is defined for the total project and budget. In many instances, oversights in such areas as site utilities, soils, logistics, or modification of existing facilities for code compliance have forced the actual programmed facility to become the "soft" item. Budgeting and estimating are areas of "black magic" that are further complicated by bidding climate, time of year, etc., for bids.

In many instances, the project budget is confused with the construction budget. The total project budget amount will usually include line item amounts for:

Lands
Architectural/Engineering (A/E) Fees
Construction Budget
Equipment and Furnishings
Administration
Miscellaneous Contingencies

Total Project Budget

A thorough project scope and budget analysis by all parties is needed to discover omissions and establish priorities before contracting for professional services and initiating design.

2. Strategies:

a. Backwards Analysis: Backwards analysis starts with a given sum of money and subtracts line item expenditures for contingencies, administration, A/E fees, equipment, and construction. Subtracting site utilities, site work, and general storage from the gross amount left for construction yields the amount left to build the facility alone. From this amount, subtract the amount required to build adequate supplementary space so the building can be operated and maintained properly. What you have remaining is an amount to build the programmed assignable area. Usually this amount is not adequate to construct what is needed. This quick analysis becomes the means of evaluating trade-offs and causes modifications to the program, project scope, or budget. Too often, this approach results in the inclusion of educational program areas at the expense of adequate storage, maintenance, and utility areas.

b. Forward Projection: Ideally, a budget amount can be projected by beginning with the programming of the desired assignable areas which start out as fixed items, adding to this figure adequate supplementary space while making adjustments for site logistics and integration with existing facilities. Site utilities such as water, sewer, and power should be thoroughly considered. Other factors are then added for equipment, A/E fees, administration, inflation, and miscellaneous contingencies to arrive at a total project budget.

End of Section

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SECTION 2.0 ENVIRONMENTAL DETERMINANTS

INTRODUCTION:

ENVIRONMENTAL DETERMINANTS are the second major grouping of critical factors affecting facilities design. Generally speaking, their primary impact is external to the facility; that is, they affect building shape, envelope, siting, material composition, foundation, and construction methods. Additionally, they affect both BUILDING PROGRAM DETERMINANTS and SITE UTILITY DETERMINANTS. The arrangement of spaces, from a functional point of view, must be tempered with such considerations as building shape and its orientation with regard to wind, snowdrifting, etc. ENVIRONMENTAL DETERMINANTS limit site utility options for such items as source, quality, and quantity of water supply.

The ENVIRONMENTAL DETERMINANTS section lists critical factors, i.e., climatological, geotechnical, hydrological, and logistical, that must be identified and utilized as a logical basis for the programming and design of facilities in the northern environment. Considerations for each determinant have been given to explain the relevance of a particular item to the facility's design.

2.1 CLIMATE:

Maritime, Transitional, Continental: Climate is primarily determined by latitude and ground and water features. In Western Alaska, the Bering Sea and Pacific Ocean offer a moderating influence on the extremes in temperature that inland areas between 56 and 66 degrees north latitude would otherwise experience. South along the Alaska Peninsula and the Bristol Bay coast, a cool maritime climate characterized by moderate seasonal temperatures exists. Further north along the coast, the Bering Sea freezes over in the winter creating a barrier to water currents. The result of this freezing over is a variation from maritime to continental climate which is, therefore, termed transitional climate. Transitional climate is characterized by moderate temperature conditions in the summer (maritime), and cold, dry, wind-swept conditions in the winter (continental).

Further inland, the land barrier to the water creates a continental climate with greater extremes in temperature and less precipitation and wind. Local variations on these climate types occur, i.e., high areas are colder and wetter, rocky capes are windier and wetter. (See Figure 2.1).

Important elements of climate for use in the design process follow.

2.11 Latitude, Longitude, and Elevation:

Considerations:

Hours of daylight during the school year are an important consideration in building design in Western Alaska. Winter days are dark, and hours of sunlight are short; in coastal areas, cloudy and foggy days are frequent. The landscape becomes white and colorless. When the sun does shine, its low angled rays cast long shadows and cause glare and overheating through inadequately shaded windows. The fall and spring hours of sunlight are adequate to be used advantageously for lighting and some heating. Using latitude, longitude, and elevation, the designer may calculate and use the following items:

Sun Altitude
Hours of Daylight
Percent of Possible Sunshine
Solar Azimuth

2.12 Temperature:

Mean Temperature (Winter/Summer)
Temperature Extremes (____ deg. F. to ____ deg. F.)
Diurnal Temperature (____ deg. F.)
Heating Degree-Days
Freezing Degree-Days
Thawing Degree-Days
Number of Consecutive Days of Extreme Temperatures
Winter Wind Chill Temperatures

Considerations:

Temperatures are directly related to the climate type. Maximums and minimums (see Figures 2.2, 2.3, 2.4, and 2.5) can be seen to follow the climate pattern. Of all determinants studied in the arctic and sub-arctic, freezing conditions are probably the most critical in their effect on any type of structural or man-made apparatus that improves the life style of the inhabitants. The intensity of the effects are determined by the duration of the freezing conditions. A period of time that is no more than a couple of hours at 0 degrees C. will only affect human beings in their personal relationship to the environment, while a period of time of several weeks or months below freezing will affect all systems, water systems most particularly.

In evaluating temperature effects on building design, the "degree-day" is used. Degree-days are the number of days per year times the number of degrees per day that temperatures differ, either above or below, from a selected standard. Heating degree-days are measured under 65 degrees F., freezing degree-days under 32 degrees F., and thawing degree-days over 32 degrees F. Heating degree-days are used in calculating heat loss and heat requirements of a building over a year's time. Freezing degree-days are used in predicting depth of frost and thickness of ice, and thawing degree-days help determine the depth of ground thaw. Where few thawing and many freezing degree-days occur, continuous permafrost is likely. For design purposes, once-in-ten-year extremes are used by adding 300 to thawing degree-days, and 1,000 to heating and freezing degree-days.

Another temperature-related consideration is the number of consecutive days that temperatures remain below a certain level. This is important in determining fuel consumption and storage capacities, building use during cold periods, and demands on building utility systems. (See Figures 2.6, 2.7, and 2.8).

1. Effects on Water System: These effects can be isolated according to the various phases of the water system. These phases include: a) the recovery portion; b) the delivery portion; and c) the storage portion, if storage is required.

   a. Recovery Portion: The recovery system can be broken down into three types: 1) a groundwater system; 2) a surface water system, which includes lagoons, lakes, and rivers; and 3) a system which utilizes sea or lake ice as a watering source.

      1) Groundwater System: The groundwater system is vulnerable to freezing conditions only when the aquifer that supplies it is relatively shallow and sensitive to active frost layer freezing. Deep groundwater sources, of course, are nonsensitive to freezing conditions (except that equipment which is placed within a well must be below the active layer to prevent bursting of pipes and damage to pumps).

      2) Surface Water System: Surface water recovery is much more sensitive to freezing conditions than any other form of recovery. Intake structures placed in lakes, rivers, or streams that freeze over are subject to damage from ice forces, i.e., those which shift or those which expand during periods of severe cold.

In addition to the physical damage to mechanical systems as freezing conditions occur over a long period of time, ice formation will continue to a point where both the quantity and quality of water are severely affected. In some regions of the arctic, ice will form to the bottom of the source, whether it is a lake, river, or stream. The only potential source of water supply in this condition is a recovery system embedded in a gravel base aquifer which may be located at the bottom or side of the surface water body.

Freezing of water tends to purify the ice, but the remaining liquid contaminates; those solids which are dissolved in normal lake, river, and stream water are forced by freezing to be concentrated into the remaining fluid. The use of such concentrated water is possible, but often requires extensive treatment before it becomes of a quality acceptable by Public Health standards.

Recovery systems are also impeded by the initial freezing of water. This initial freezing causes a condition called frazilice. Tiny ice slivers congregate on the surface of the water source; these tiny ice slivers attach themselves to intake structures and clog them. Once the intake structure is totally closed over, the pumps will continue to try to draw water through the opening and pump damage may result.

3) Utilization of Sea or Lake Ice as a Watering Source: The third form of water recovery that is temperature and time dependent is lake or sea ice. This is the traditional method that has been utilized in the arctic and sub-arctic regions by the natives for many centuries. During wintertime recovery, bands of people go out on rivers or lakes, or even on old pack ice where the ice is relatively pure, and cut blocks of ice, returning with them to their homes where they are subsequently melted by artificial means. This requires an extensive labor force, as well as a constant heat source for melting. In some locations in the arctic and the sub-arctic, this is the only potential form of wintertime water recovery used at present.

b. Delivery Portion: Time duration of freezing conditions is particularly harmful to delivery systems. Unprotected delivery systems, e.g., pipes laid either on the ground or in the active frost layer, are subject to freezing. Ice will form at a point in the pipe where it is most exposed to freezing temperatures. This ice will restrict flow in the pipe until it is entirely clogged. Pressure in the pipe from the water being displaced by the expanding ice will seek a point in the pipe wall or at a joint which is weaker than any other area, and at this point the pipe may break; the broken pipe does not always occur where the ice is located. The difficulty in buried pipe is that breaks are not always at a point where they are easily accessible. Wintertime repair of broken pipes is very difficult because the ground is frozen and difficult to excavate with mechanical or hand methods.

Pipes that are insulated with urethane or some form of expanded insulation, or which are placed in insulated utilidors, are more resistant to freezing conditions, but still suffer the same type of damage unless additional means of heat energy is supplied. This often requires mechanical devices that can provide heat through heat tapes, or recirculating systems which involve dual lines. Delivery systems are particularly susceptible to freezing conditions at points where they come from the ground, if they are buried, and enter into buildings. Differential movement of a building can break pipes by tearing them from their joints. The difference in temperature between the ground and outside air can provide a susceptibility to expansion and contraction that is greater than any other point in the system, and poorly designed connections can result in leaks and glaciation.

c. Storage Portion: The storage systems are subjected to many similar forms of damage from freezing conditions. The inability of a static system of water to retain heat in temperatures below freezing results in a build-up of ice in storage tanks and structures that can possibly damage the tank to a point where it is totally unusable. In areas where storage tanks provide the winter supply of water, the freezing of ice and withdrawal of water underneath that ice creates an ice bridge that can fall and damage the piping systems in the tank. The repair of such situations is exceedingly difficult; an entire remainder of the season's water supply has to be drained before repairs can be made on those damaged structures.

2. Effects on Waste Water System: Freezing conditions are particularly of interest to waste water systems as applied to treatment lagoon structures. Long duration of freezing conditions, with attendant growth of ice over lagoons, directly determines the size of the lagoon that is required to provide both anerobic and aerobic action on waste water.

   In those situations where an outside extended aeration treatment plant is utilized, the length of freezing conditions determines storage requirements necessary for this type of treatment.

   When septic tanks are used as a form of waste water disposal, the length of freeze and depth of the active frost layer will determine whether a septic tank and soil absorption system is possible.

   The length of freezing conditions also determines the requirements and use of buried transport systems. In those areas where the permafrost layer is close to the surface, aboveground transport systems are required, which necessitates the use of insulated pipe and the addition of heat energy to reduce the damage to the pipeline from freezing.

3. Effects on Solid Waste Disposal: Freezing conditions particularly affect solid waste control, in that freezing time duration will determine the use of sanitary landfills. Wintertime use, with long periods of extensive cold, will make the use of earth cover over solid waste almost an impossibility. Stockpiling of materials until spring is the only course available at the present time, but presents hazards because springtime flooding and wind-blown transport of solid waste can cause environmental hazards. During those periods of thaw, transport of solid waste to the disposal site may be virtually impossible due to the impassable conditions of roads that lead to these sites.

2.13 Precipitation:

Mean Annual Precipitation
Mean Annual Snowfall
Maximum Snowfall in 24 Hours
Design Snow Load
Snowdrifting Characteristics

Considerations:

The lowlands of Western Alaska receive 20-40 inches of total precipitation yearly, although higher elevations receive considerably more (up to 200 inches). Snowfall patterns follow total precipitation patterns; the highest snowfall areas occur inland and total snowfall tends to decrease from south to north, and from higher elevations to the lowlands.

Rainfall in Western Alaska is relatively low compared with Southern Alaska. It is spread out over the summer and does not fall in intense storms except in late fall. This is a significant factor in evaluating potential water supply and storage systems.

Snowfall directly affects structural design. Snow load is determined by the depth and density of snow; the deeper the snow does not necessarily mean the greater the load. Density of snow varies with the humidity of the region, as well as the length of time it has been accumulating. Snow tends to be wetter and heavier in the maritime regions, and drier and lighter further north and inland. (See Figures 2.9, 2.10, 2.11, and 2.12).

Snowdrifting occurs in windy areas where the snow is light and dry, primarily along the coast in the transitional climate zone, although local effects can alter this. Ridges and banks can trap snow or channel wind to create more pronounced drifting. A building itself can create a snow or wind barrier and create adverse drifting patterns. Building access can be blocked by drifting. Building design, e.g., elevated, and orientation with regard to prevailing winds, can alleviate these problems.

2.14 Wind:

- Winter Winds:
  - Prevailing:
    - Speed
    - Direction
    - Frequency
  - Storm:
    - Speed
    - Direction
    - Frequency

- Summer Winds:
  - Prevailing:
    - Speed
    - Direction
    - Frequency
  - Storm:
    - Speed
    - Direction
    - Frequency

- Katabatic Wind (as Affects Winter and Summer Winds)
  - Cold air drainage down hillsides toward low-lying areas prevalent in the continental region during clear periods in the winter.
- Design Wind Load

Considerations:

The Western Coast of Alaska has notoriously high winds, and calm conditions occur only 5-15 percent of the time. Inland areas are considerably less windy, but local topography can alter this. Prevailing winds have a major influence on building site selection and orientation, and on heat loss from the building through infiltration. Wind load affects structural design and is measured in pounds per square foot of building surface. It increases with the square of the wind speed, and with height aboveground. Along river drainages and on the Alaska Peninsula, trees provide a windscreen; but in more exposed areas, gusty winds present a greater design problem. Wind-generated electricity is feasible in areas of moderate, steady winds. (See Figure 2.13). Wind combined with snowfall establishes snowdrifting patterns.

2.2 GEOTECHNICAL AND HYDROLOGICAL: Important elements of geotechnical and hydrological determinants for use in the design process follow.

2.21 Geotechnical:

2.211 Topography:

- Village composite plan with contours at 10 foot intervals; site plan with contours at one foot intervals.
- Village composite plans should show land use and existing structures, utility systems, existing or geographic features applicable to utility development, transportation systems or avenues, and predominant geological features.

Considerations:

Topography is the primary factor in site selection. The site must be high enough to be out of flood danger, have enough area for playground space and still be adequately drained, have access to off-site utilities, and be accessible to the town. It must also be safe from erosion and clear of adverse soil conditions.

2.212 Soils:

Composition (Subsurface and Surface)

Considerations:

In low-lying regions of Western Alaska, predominant soils are poorly-drained silts and sands, underlain by discontinuous permafrost and covered by peaty mats or, along rivers, by trees and brush. The uplands and ridges are of coarser sand and gravel and are generally well-drained and dry. The islands and north facing mountainsides and ridges present a shallow layer of soil underlain by bedrock. Problems for construction are presented by frost action in wet soils, by permafrost in ice-rich silt, and by certain other soil types and situations.

Soil types in Western Alaska run the range from bedrock to coarse-grained to fine-grained soils. Bedrock provides a good foundation material, whether frozen or unfrozen, although it is not found in many of the villages as it occurs at a higher elevation less favorable to settlement. Coarse-grained materials, including boulders, cobbles, gravel, and sand, are also good foundation materials and are found in flood plain areas. Well-graded (proportionate mixture of sizes of grains) sands and gravels are easy to compact (for stability), little affected by moisture (minimal shrinkage and swelling), and not subject to frost action. Fine-grained soils, mostly silt and clay, present problems in both their frozen and unfrozen states and are extensive in Western Alaska. Silt, although relatively impervious, is unstable, especially when the moisture content is increased; it tends to become quick (collapse) when saturated. It compacts poorly, is a major cause of frost heaves, and erodes easily. Clay, too, is difficult to compact although it resists erosion and frost heaving. It shrinks and swells considerably with moisture content. (See Figure 2.14).

These soil types are rarely found alone, but generally as a gravelly silt or silty sand or some other combination. The proportion of one grain type to another in a given soil determines the properties it will exhibit, and so its action and affect on foundations can be predicted. In addition to these soil types, organic matter may also be present. It increases compressibility and reduces stability in fine-grained soils, and is highly susceptible to moisture in changing its properties. Its decay and associated chemical changes are unpredictable and make it a poor foundation material.

2.213 Permafrost:

Temperatures
Percent of Solids
Depth of Permafrost
Depth of Active Layer
Vegetation

Considerations:

Permafrost is perennially frozen ground. It occurs in bedrock and free-draining gravel, as well as silts and sands; it varies in depth from a few inches to hundreds of feet. It is continuous in Northern Alaska, and intermittent further south; ground below river beds is generally unfrozen. Permafrost is insulated from surface temperature fluctuations by vegetation and a layer of soil called the active layer which freezes and thaws yearly.

When permafrost in ice-rich soils (silts, clays, or fine sands) is allowed to melt, water rises to the surface and the land sinks. This creates a bog and, if not drained, the standing water can further degrade the permafrost. In construction, this causes uneven settlement, as well as site problems from water. However, permafrost, if kept in its frozen state, is stable and a good material for building on.

Permafrost in soil is generally impermeable to water, and surface drainage is required. Site drainage should divert flowing water away from structures built on permafrost to avoid thawing of the permafrost. (See Figure 2.15).

1. Effects on Water System: Permafrost is the second most important environmental determinant to affect water supply systems. Each form of permafrost, continuous and discontinuous, has its own particular problems as it affects a water system.

   Continuous permafrost can have an overburden that varies between 12 inches in the northern portions of the State, to as much as 12 to 15 feet in those areas that are further south. This overburden consists of soils that are silty, sandy, gravelly, or a combination of all. In the more northern regions, the active frost layer penetrates the soils and descends to a point where it is immediately contiguous with the permafrost layer. In more southerly regions, this active layer will go only to a depth that is dependent upon the length of freezing time. Construction of water utility distribution systems, in areas where the active layer does not abut the permafrost layer, is reasonable only if the thermal characteristics of the utility are considered and protection is provided to resist melting of the permafrost layer beneath. Those areas where permafrost reaches a point approximately 12 inches below the surface of the ground are difficult for the use of buried pipelines without extensive blasting or breaking of that permafrost layer, particularly if the soils consist of a sandy silt mixture. There are some regions where permafrost consists of a well-drained, fine gravel; burial of utility systems in this type of material is reasonable, but consideration must be given to protection of the fluid within the utility system.

   In poorly-drained ice-rich soils, the forces present can move pipelines and storage structures, and cause system damage from ice-jacking. In systems where the material used is not tremendously strong, the seasonal jacking of the active frost layer can cause breakage or crushing of pipe. Storage tanks which are set on this type of ice-rich foundation require extensive methods for insulating the bases so that there is minimum heat loss to the ground.

Thermal degradation in permafrost causes thaw bulbs under the structures or under the area that is exposed to heat. These thaw bulbs can result from stripping of the topsoil, which allows thawing from radiant energy from the sun or from heat introduced from a warm source such as a water pipe system. In ice-rich soils, this thaw bulb will cause consolidation of the soils, resulting in a void underneath the structure. Bridging of these voids or these depressions requires attention to the support form. Thaw bulbs can result under structures such as dams or reservoirs; the particular problems that are active in this situation are those that can create destruction of a dam over a period of time. As the thaw bulb increases under the foundation material, water may penetrate and leak through to the downstream surface. This can cause subsidence in the dam structure and ultimate failure.

From the positive viewpoint, the use of the active frost layer in permafrost areas can be of benefit in construction of water utility systems. Much of the area of Western Alaska is of a marshy, boggy nature. This provides difficulty in construction of utility or pipeline systems because equipment must operate in wet, mucky soils. Ditches are not kept open easily; facilities for pumping water out of ditches are required, and the overall cost of the development of any type of distribution system is increased. By positive use of the active frost layer and utilizing a winter construction program, distribution systems can be laid on, or in, areas that would be exceedingly difficult to penetrate in a summertime condition. Careful planning is required, though, to determine when an active layer has penetrated the soils to a point where it will support heavy weights, such as backhoes or bulldozers, but not to a point where the active layer has penetrated to a depth where construction is virtually impossible due to the impenetrability of the permafrost.

Construction of water recovery systems in permafrost has abundant problems. The use of wells for recovery of groundwater supplies is indicated only in isolated instances. The mechanical characteristics of permafrost are particularly harmful to casings of wells. Once a well in permafrost has been put into operation, it must be kept flowing to preclude freezing. Wells that have artesian characteristics, i.e., where water stands in the casing above the aquifer, will require much special attention to remain in service.

Thawing and freezing of the active layer may cause structural damage near the surface. In addition, the interface boundary of the active layer with the permafrost layer provides a condition for thawing of portions of the permafrost immediately adjacent to the casing. This results in the active layer progressing downward in the wintertime, providing a jacking action to the casing. This action pulls the well casing out of the ground, possibly damaging the screen or destroying the alignment of the pump or drop pipe.

In those areas where mechanical damage is avoided to the well itself, quite often the water supplies that are available under permafrost layers are highly saturated with total dissolved solids. This concentration of material in the water requires extensive treatment before it becomes tolerable for human use. In portions of the interior, water can develop a highly acidic nature which is very corrosive to pipes and piping components. Those wells which penetrate the permafrost in coastal areas usually pick up an aquifer which is contaminated with salt water, and the water may be exceedingly brackish. This type of water requires extensive and complicated mechanical or chemical treatment. When used as a "gray water" system only, or for washing dishes or flushing toilets, the water supply is adequate, but it is still corrosive to materials.

2. Effects on Waste Water System: Permafrost is a critical determinant and will affect the availability of using waste water lagoons. In some areas where permafrost is close to the surface, the thaw bulb generated by a waste water lagoon will cause subsidence due to melting and consolidation of the materials below. On-site septic tank systems are usually not used in permafrost areas. Cold ground temperatures slow down the biological action to a point where the time involved becomes too long for effective removal of contaminants. Permafrost will also determine the use of buried systems, or nonburied systems. Pipes must be insulated so as not to thaw permafrost, and also not to be frozen by the permafrost. The most common solution to the problem is to elevate sewer pipelines aboveground on piling, and to insulate them against the weather.

3. Effects on Solid Waste Disposal: Permafrost makes sanitary landfills difficult to operate because pits are hard to excavate and cover material may not be readily available. Permafrost itself provides a system of permanent cold storage or refrigeration for any waste material that is disposed of on it; the natural degradation of papers and other debris is retarded by the preservative quality of permafrost.

2.214 Geology:

Seismic Zone
Identification of Acceptable Usable Gravel Sources

Considerations:

Southwestern Alaska is active seismologically, but few earthquakes have been recorded further north. Several faults have been mapped.

Western Alaska is still a young land, geologically speaking, and many hot springs exist in areas near granitic intrusions. Most are not hot enough for commercial use, but may provide auxiliary heating. There are a few exploitable coal deposits in Southwestern Alaska, especially on the Alaska Peninsula.

Sand and gravel are available in many stream beds, as well as ridges and banks. Care must be taken in selecting a borrow site for its potential effect on erosion and landsliding. The method of transporting it to the site, the quality of material, and total cost must be taken into consideration. (See Figure 2.16).

2.22 Hydrological:

2.221 Flooding and Erosion:

High Water Elevation
Graph of Erosion Trends

Considerations:

1. Flooding: Many of the villages in Western Alaska are built on flood plains. Flooding is caused by ice jams during spring break-up, by glaciation during winter, and, on smaller rivers or streams by unseasonal amounts of rain or snow, or early melting of snow. Flooding is also a threat in coastal areas from wind-driven waves during fall storms.

   a. Effect on Water Systems:

      1) Fresh Water Flooding: Fresh water flooding is a consideration that affects many of the villages along the lower Yukon and Kuskoquim areas. Floods occur both at spring break-up times and during the August and September rainfall periods. Those that occur in spring are usually more harmful to all elements of habitation, including the water system, because they are caused by ice jams that block river flows. These floods are extensive and cover many square miles of land when they occur.

Proper consideration for the siting and design of a water transport and storage system is necessary in those areas where floods are expected on a reoccurring basis. Provisions for tied-down structures are necessary to prevent the particular storage tanks or materials from floating away and being damaged.

Fresh water flooding also carries the problem of excessive siltation. If silt is introduced into a pump system, it can damage the pumps and become a very expensive maintenance problem.

Debris carried by flooding can cause structural damage, both to piping systems and pumps or storage tanks that are involved.

Fresh water floods, along with other damage, have the potential of being a disease vector because contamination from septic tanks and privy pits is carried from their disposal area into the source waters of the water supply. Particular care must be taken after floods to provide adequate decontamination of all systems and all water supplies.

2) Salt Water Flooding: Salt water flooding occurs along coastal areas of the Bering Sea. Salt water flooding is developed from August and September wind-driven storms that accentuate high rising tides. This water floods over villages and contaminates fresh water supplies such as lagoons and lakes. In those areas where recurrent flooding is the norm rather than the exception, care must be given to the establishment of a fresh water supply. Protection such as dikes and high berms is not always adequate to protect a source of water.

A few villages in Western Alaska derive their supply of water from rivers that empty into the Bering Sea. These rivers are affected by tidal action which carries salt water upstream on a periodic basis each day. When intake structures are located in such a manner that tidal waters come into contact with them, the water system is contaminated by saline water. Particular care must be utilized in these situations to insure that the intake of a water transport system is located well above tidal intrusion.

Salt water intrusion into the groundwater system can occur, both from flooding and from drawdown in wells. When fresh water wells are drilled in areas that are adjacent to salt water, the drawdown that is developed by village usage often results in salt water flowing from the ocean into the fresh water aquifer. Recharge of this aquifer by fresh water is always difficult, and quite often impossible, resulting in a contaminated well that cannot be used as a potable water supply.

b. Effect on Waste Water Systems: Flooding is a determinant to waste water systems because both fresh and salt water flooding can damage or destroy the biological community in a waste water lagoon or in a septic tank. The reestablishment of these organisms may require emptying of such treatment facilities after the flooding subsides, and will require active monitoring by personnel assigned to maintain the systems.

When privy pits, septic tanks, and waste water lagoons are utilized as a waste disposal system, flooding can provide a form of carrier that would take the contaminated material and spread it to ground that is used as a potable watershed.

Debris carried by floods can damage aboveground structures just as in potable water supply systems. These structures can be washed away, clogged by debris, or moved out of line in such a manner that gravity flow is not possible.

c. Effect on Solid Waste Disposal: Fresh and salt water flooding, too, have the ability to redistribute solid waste around the countryside. Contaminants that are partially decomposed can contaminate a potable water supply. Location of sanitary landfills to preclude damage from fresh and salt water flooding is necessary.

2. Erosion: Erosion is a major consideration, both along river banks and in coastal areas. Mechanical erosion is done by water action during the summer months. In frozen soils, this is accelerated by thermal erosion when water thaws soil as it undercuts banks, and unstable conditions propagate. This is especially a problem in fine-grained soils with water already frozen in it. In river areas, the banks are of alluvial material and easily undercut. As stream beds are channelized, as through removal of gravel, their velocity increases and they become even more erosive.

Solifluction, another form of erosion, is the slow gravitational movement of saturated soil over permafrost during summer thaw. This happens on sloping sites, especially when the vegetative mass is broken or when extra weight has been placed on the slope. Landslides or rapid soil movement is rarer, but potentially much more hazardous. Cutting away natural embankments through site or borrow excavations, increasing runoff, raising the water table, and thawing ice-rich permafrost are all factors contributing to landslide movements.

2.3 LOGISTICS: Moving building materials, maintenance items, and trained personnel to the project site are some of the major problems in building and operating facilities in rural Alaska. In some cases, a design must be altered because of the impracticality of transporting materials (e.g., aggregate for concrete) or equipment (e.g., pile drivers, backhoes). With careful planning and scheduling, some of these problems can be avoided during construction, and later when servicing is required.

The resource base (for construction materials, spare parts, and maintenance personnel) for Western Alaska is Fairbanks, Anchorage, and the West Coast of the Lower 48. Most sites in Western Alaska are accessible at different times of the year by water, light aircraft, and, to a limited extent, surface vehicles. Although boat and barge rates are considerably cheaper, the time enroute and nature of shipping tends to add costs for storage and construction delays. Additionally, scheduling for completion of a facility or the immediate need for spare parts or servicing often precludes use of these slower transportation systems. In many cases, the result is that air becomes a reasonable, if not the only, alternative.

2.31 Scheduling:

Location
Projected Completion Date for Construction
Other Construction Projects in Vicinity

Considerations:

1. Location: How far is the project site from major supply points, for example, Anchorage and Fairbanks, or staging areas (e.g., Kotzebue, Nome, Bethel)?

2. Critical Path of Tasks and Time: Projection of the desired completion date for a facility is the first step in beginning to schedule the occurrence and timing of events that must take place in order to meet that end date. In many cases, this exercise will show that the completion date is unrealistic when considering the length of time required to complete each task, and also how the scheduling of soils investigations, design, bidding, ordering materials, placing foundations, and enclosing the building are affected by the time of year in which these events should occur.

The school district, State, and A/E need to establish as early as possible the Critical Path of Tasks and Time which must include provision for the necessary reviews and approvals.

3. Using Lead Time: Barging and air shipment can be used in tandem. Airlifting foundation, flooring systems, and heavy machinery during winter can enable an early start in the spring or even foundation placement before thawing commences (depending on foundation type); and, meanwhile, barging the rest of the materials for arrival by mid-summer for completion by winter is a feasible construction schedule. Drill rigs flown in for foundation work in winter can be backhauled via water to a larger local port.

   The first freighters leave Seattle at the end of April so equipment and goods from distributors in the States must be selected and delivered by then. These arrive in Western Alaska by early June, and depending on the site, can be delivered by the end of June. The last freighters leave in late August and could be used if delays occur in obtaining goods by earlier sailing times. Barges downriver from Nenana have a shorter season (mid-June to mid-August), but can be expedient for in-State or trucked-up materials. Freighters can also be used to deliver goods to the nearest off-loading point where they can be stockpiled to be moved to the site when the ground can be worked on. This method requires a safe storage area, and depending on the type of material stored, a dry and warm shelter as well. It also requires that enough lead time and money be allotted for the materials, but can save in transportation costs.

   Air connections, too, are seasonal. In areas without adequate landing strips, winter strips can be built. Generally, this is done in February for use in March and April, and requires machinery at the site. Another alternative is to lengthen the existing runway for use of larger aircraft. In commercial fishing areas with adequate runways, certain times in the summer provide the charter service with a backhaul to rural areas from large cities and can substantially reduce rates.

4. Coordinating Construction Projects: Coordinating construction projects in neighboring areas can reduce the burden on a single contractor for mobilization, and certain trade-off benefits could result in more economy. However, if two or more projects will be under construction simultaneously in the same village, these projects should be coordinated to avoid conflicts regarding use of local equipment, lodging, and labor.

2.32 Air:

Description of Runway/Landing Characteristics Including:
- Length
- Condition
- Use Limitation

Identification of Applicable Carrier Characteristics:
- Size and Type of Carriers (Aircraft)
- Cargo Size Limitations
- Schedule Limitations

Considerations:

Western Alaska is served by two major air carriers, Wein Air Alaska, Inc., and Reeve Aleutian Airways, Inc. There are also many small bush and charter air carriers.

Wein is the major air carrier, flying freight and passengers between Anchorage and Fairbanks in large 737's. (See Figure 2.17). From there, passengers and goods are usually flown in smaller planes, either under contract with Wein or by local charter. These smaller planes usually hold only eight passengers, and while practical for passengers and small goods, would not work for hauling construction materials. Reeve also flies from Anchorage to several points on the Alaska Peninsula; from there, air charters operate.

Air charters (from Anchorage and Fairbanks) range from small to large in plane size. The largest include Hercules, Twin Otters, Sky Vans, Caribous, DC-3's, and Electras. Twin Otters can take beams and plywood, and Caribous can take vehicles and small heavy machinery as well as construction materials. Both are equipped to take off in under 2,500 feet. This is a definite advantage over DC-3's, Electras, and Hercules which need over 5,000 feet of runway. When the ground is frozen with a good cover of snow, however, the runway may be lengthened to accommodate large planes. This would require heavy equipment at the site, but may be a workable solution to major freight moving. In addition to large planes, several air charter services have scheduled passenger flights to Wein and Reeve's major points. (See Figure 2.18).

Although there are several sea-plane bases in Western Alaska and numerous lakes and stretches of river water to accommodate them, there are few float planes available large enough to handle construction materials.

Rates: For cargo moved via scheduled flights with Wein and its subcontractors, rates are price per pound; for points beyond the major transfer points, they must be prepaid. For charter flights, rates are hourly and vary with the type of plane chartered. For Hercules charters, rates are per mile.

AIRCRAFT SPECIFICATIONS

AIRCRAFT	LENGTH OF RUNWAY	PAYLOAD* WEIGHT	DOOR SIZE H W	INTERIOR DIMENSIONS H W L	RATES
CARIBOU	1500'- 2000 Feet	6500-7000 lbs. (30 passengers)	6' x 6' (tail)	6' x6' x 28 1/2' length up to 40' w/door open	$750/hr.
SKY VAN	2000 - 2500 Feet	3500 lbs.	6' x 6' (tail)	6' x 6' x ;9' up to 30' w/door open	
DC-3	3000'plus	5000 - 6500 Lbs. (28 passengers)	5'-4" - 4'8" (Side)	6'-2" 6'6" x 7'6" x 26' -8"	$500/hr.
TWIN OTTER	1000'- 2000 Feet	1670-3500 lbs. (19 passengers)	4'-2" x 4"-8" (Side)	4'-2" x4'-8" x 20'	$560/hr.
HERCULES	5000' plus	42.500 - 45,000 lbs.	9' x 10' (Tail)	9'x 10' x 54'	$8.81/mi. -500 mi. $7.56/mi. +500 mi.

* NOTE ON PAYLOAD WEIGHTS: THESE VARY WITH AMOUNT OF GAS - FOR THE SHORT DISTANCES OR FREQUENT REFUELING STOPS, THE LARGER FIGURE APPLIES.

2.33 Water:

Description of Water Transport Systems Available Including:
Identification of Routes
Size and Type of Carriers (Ships, Barges, etc.)
Cargo Size Limitations
Schedule Limitations

Considerations:

1. General: Most of the heavy cargo in Western Alaska goes via freight and barge from Seattle. There are no ports which take vessels with over 20 feet of draft north of the Aleutians so litering and barging are routine. BIA runs a freighter up the West Coast of Alaska three times a season serving the Mainland, and Little Diomede, St. Lawrence, and Nunivak Islands as well. Several commercial shipping firms, e.g., P.A.L. and Crawley-Maritime, also run freighters to points on the Western Mainland. (See Figure 2.19).

2. Major Off-Loading Points: Dillingham, Bethel, Nome, St. Michael, and towns at the mouth of the Yukon River receive freight and barge it upriver or to nearby coastal villages. Several large barge lines, e.g., Yutana Barge and Black Navigation, run up the Yukon and Kuskokwim Rivers, as well as their tributaries. Local barge lines and individuals with riverboats also run short distances from trans-shipping points, and are often available on local inquiry.

   Connections other than upriver from the Bering Sea are possible. Goods shipped to Anchorage or trucked over the Alcan Highway can be trucked or moved by train to either Fairbanks or Nenana, and from there down the Tanana to the Yukon and points above or below. There is a portage road from Kamishak Bay on Cook Inlet to Lake Iliamna.

3. Rates: Rates are usually by unit weight and type of cargo transported on major freight and barge lines.

4. Navigability: The shipping season is dictated by the time of year when waters are free enough of ice to be safe. For freighters on the Bering Sea, this is usually June to September; they leave Seattle between early June and early August to return before freeze-up.

River shipping seasons vary from late May to early October on the Kuskokwim, and shorter up from late May to late August on the Koyukuk. During normal water levels, the Yukon can accommodate riverboats up to Whitehorse, the Koyukuk to Bettles, the Tanana to Nenana, and the Kuskokwim to McGrath. At times of low water, conditions deteriorate considerably, but during high water, more rivers are open and upper reaches of tributaries can be plied. The Wood River from Dillingham to Alleknagik, and the Kuichak River from Naknek to Lake Iliamna, are two examples. (See Figures 2.20, and 2.21).

2.34 Surface:

Description of Land Transport Systems:

Roads, Trails, etc. Seasonal characteristics (e.g., winter use only, etc.); interface with air and water transport systems; condition of roads and trails; and identification of use limitations with regard to size and weight characteristics of carriers.

Considerations:

There are several small, disconnected highways in Western Alaska. Most are maintained by the State. The Nome system and Ophir to Takotna are open only during the summer, but the Takotna-Sterling Landing, King Salmon-Naknek, Iliamna-Newhalen, and Dillingham-Alleknagik roads are open year-round.

In addition, many villages have a local road system and several pickups and cars. In winter, travel on winter trails and frozen rivers and lakes is possible. This is most often done by snowmachine, which is not a major cargo carrier; larger tracked vehicles could be used, though, both in winter and summer. During summer, however, certain clearances may have to be obtained from the Bureau of Land Management.

2.35 Availability and Skills of Local Labor:

Considerations:

1. Availability of Skilled and Unskilled Labor: The desired extent of utilization of local labor can influence the design of the facility as to the appropriate technology. In most cases, wood technology is more familiar to bush villages than steel.

Local participation in construction will depend on familiarity gained through experience constructing homes and village facilities, or will involve new training. Buildings which require sophisticated equipment or training will require special crews to be brought in for construction and repairs. Technological concepts to be addressed by the owner and A/E during program/design include:

a. Local Knowledge:

   1) Materials used in village.
   2) Assembly methods used locally.
   3) Familiar assembly methods of sophisticated components which arrive preassembled.

b. New Technology:

   1) Training of local labor force.
   2) Maintenance of new technology locally.

c. Perceptions:

   1) "Fit" in village environment attitudes.
   2) Other applications of new technology in village.

2.36 Availability of Local Equipment:

Condition
Ownership
Conditions of Use, i.e., Rental, Loan, Sale, etc.

2.37 Communications:

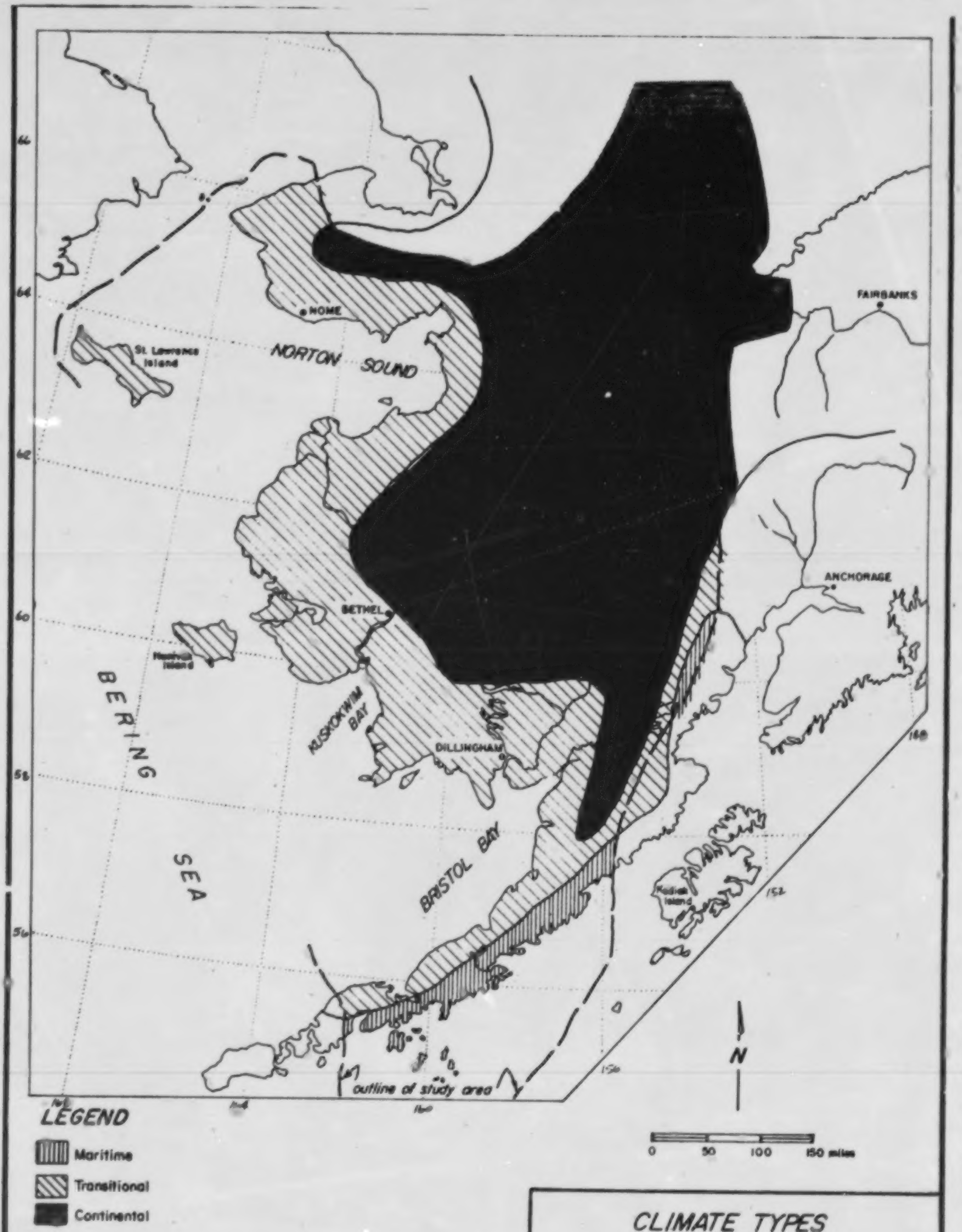
Identification of Systems Available

Considerations:

Communication with the village and people involved with the school or school addition can substantially answer many logistics questions. Locally used methods of transportation, local barge service, and vehicles, machinery, and equipment already present can reduce logistics problems. Coordinating the work force can be accomplished, especially with the advantage of hiring local labor. Work camps, lodging facilities, fuel supply.

Many villages in Western Alaska have a State or RCA bush phone, or are served by commercial phone systems. These are not always dependable outside their own service districts due to overcrowding of circuits. The more reliable form of inter-village or intra-State communication is the telegram, delivered either by telephone or mail. Citizens' band radios are popular in commercial fishing communities, but these are private, as are BIA and PHS radios.

End of Section


NOME
FAIRBANKS
St Lawrence Island
NORTON SOUND
BETHEL
ANCHORAGE
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
BRISTOL BAY
Kodiak Island
outline of study area
N
0
50
100
150 miles
LEGEND
Maritime
Transitional
Continental

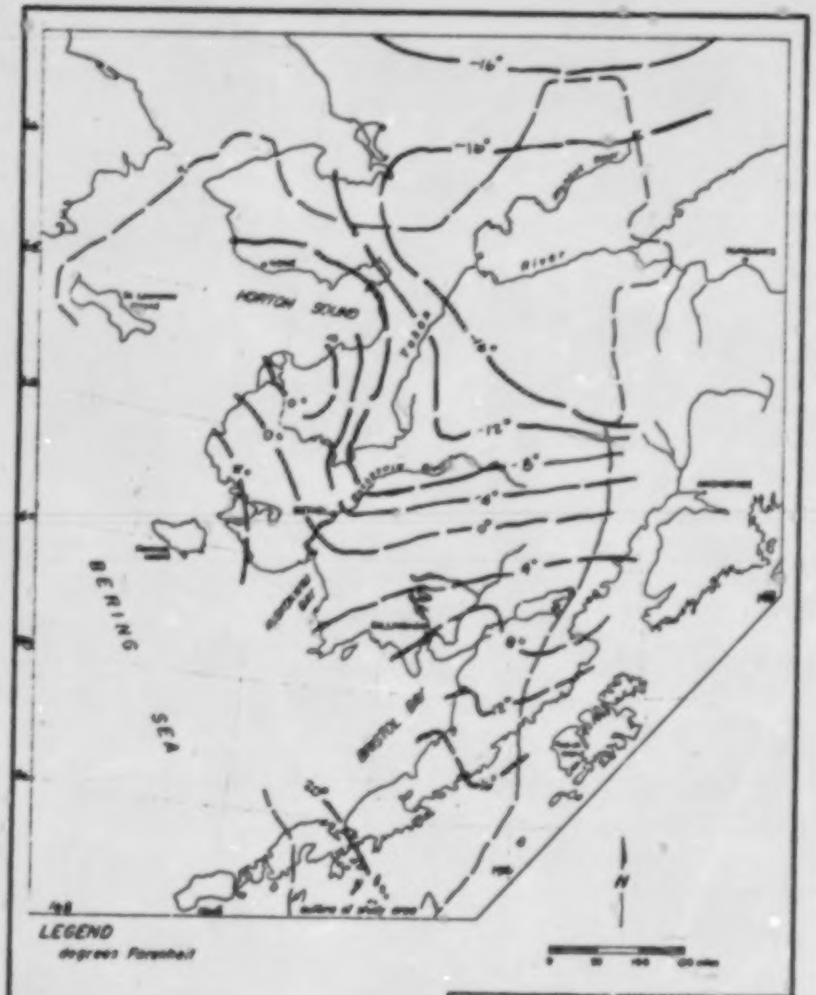
CLIMATE TYPES
of Western Alaska

from Fed-St LUPC Regional Profiles

FIGURE 2.1

Section 2.0/Page 21 a. 47

Section 20 / Page 21 b.

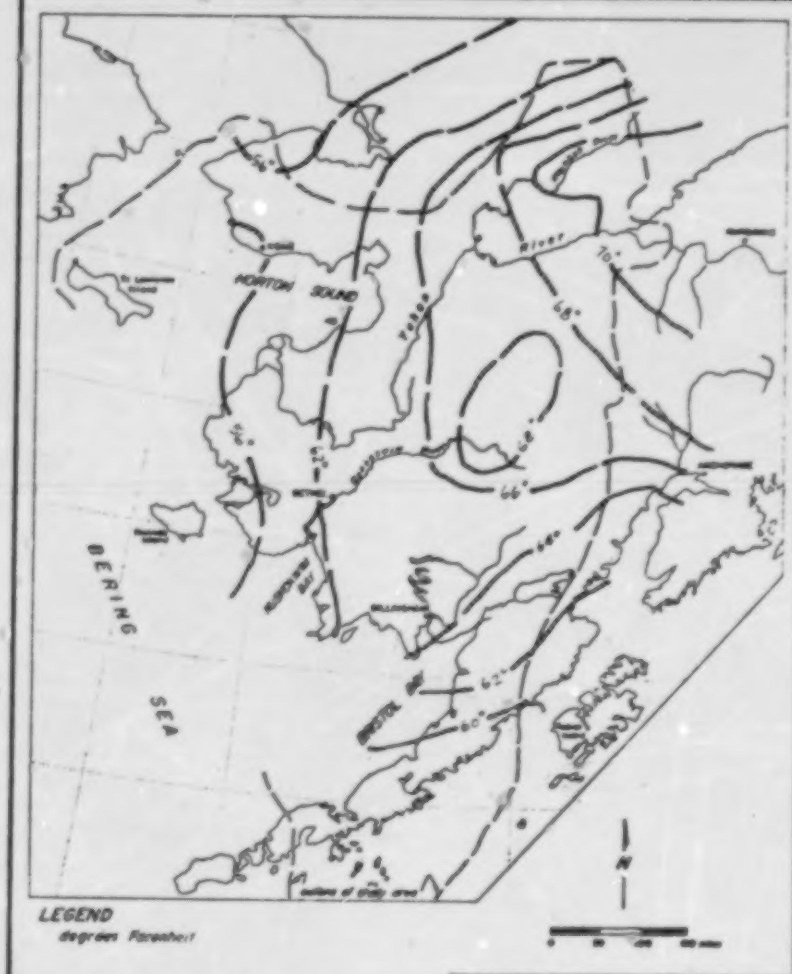


-16°
-16°
-16°
-12°
-8°
-8°
-8°
-4°
0°
0°
4°
8°
HORTON SOUND
Yukon
River
BERING
SEA
BRISTOL BAY
N
LEGEND
degrees Farenheit

AVERAGE MINIMUM TEMPERTURES

from Fed-St LUPC Regional Profiles

FIGURE 2.2



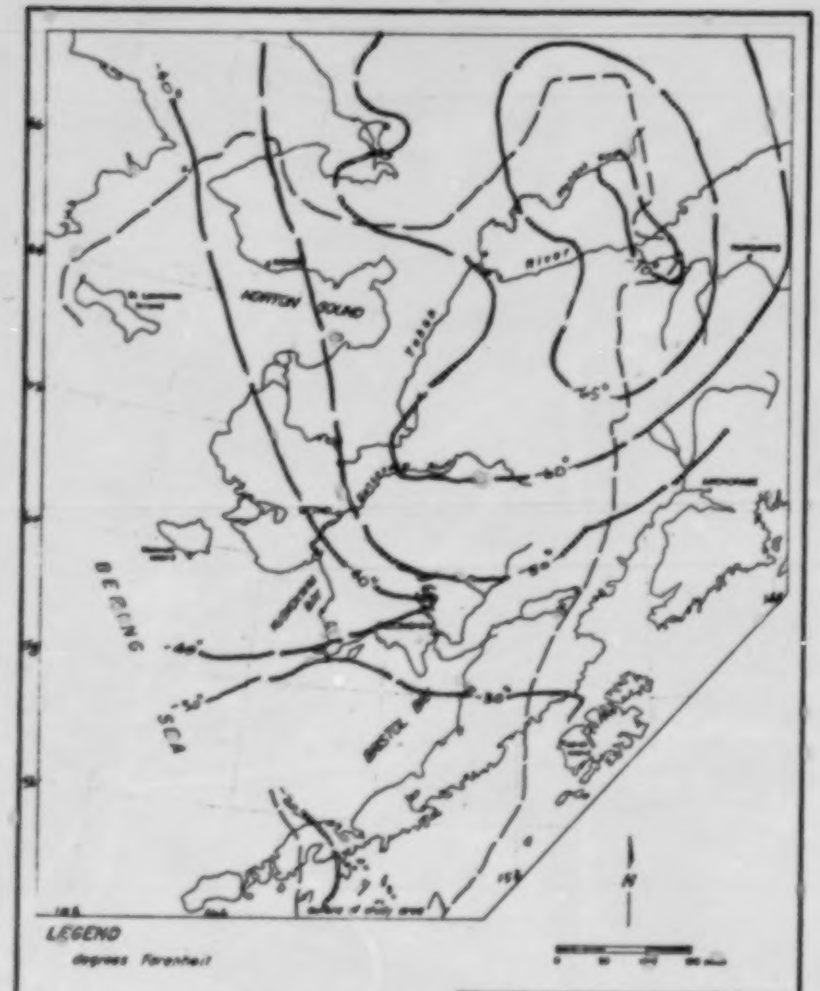
56°
60°
62°
64°
66°
66°
68°
70°
62°
60°
HORTON SOUND
Yukon
River
BERING
SEA
BRISTOL BAY
N
LEGEND
degrees Farenheit

AVERAGE MAXIMUM TEMPERATURES

from Fed-St LUPC Regional Profiles

FIGURE 2.3

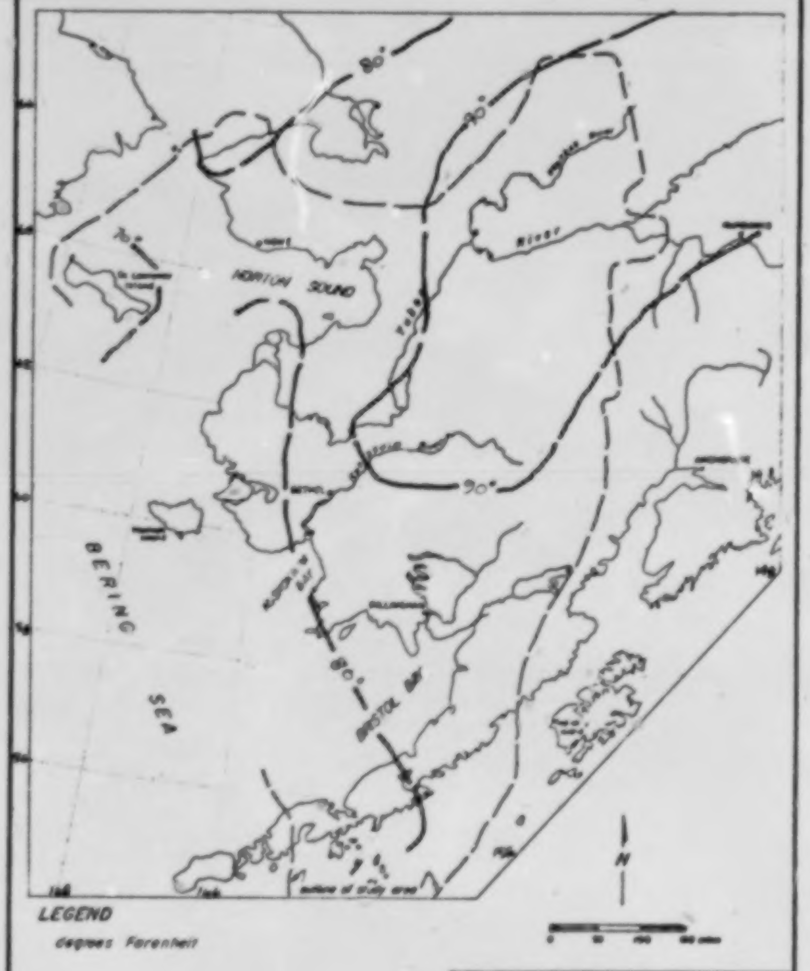
Section 2.0 / Page 21 C


-40°
NORTON SOUND
Yukon
River
-70°
-65°
-60°
-50°
-40°
-40°
-30°
-30°
BERING SEA
BRISTOL BAY
outline of study area
N
LEGEND
degrees Farenheit

EXTREME MINIMUM TEMPERATURES

from Fed-St LUPC Regional Profiles

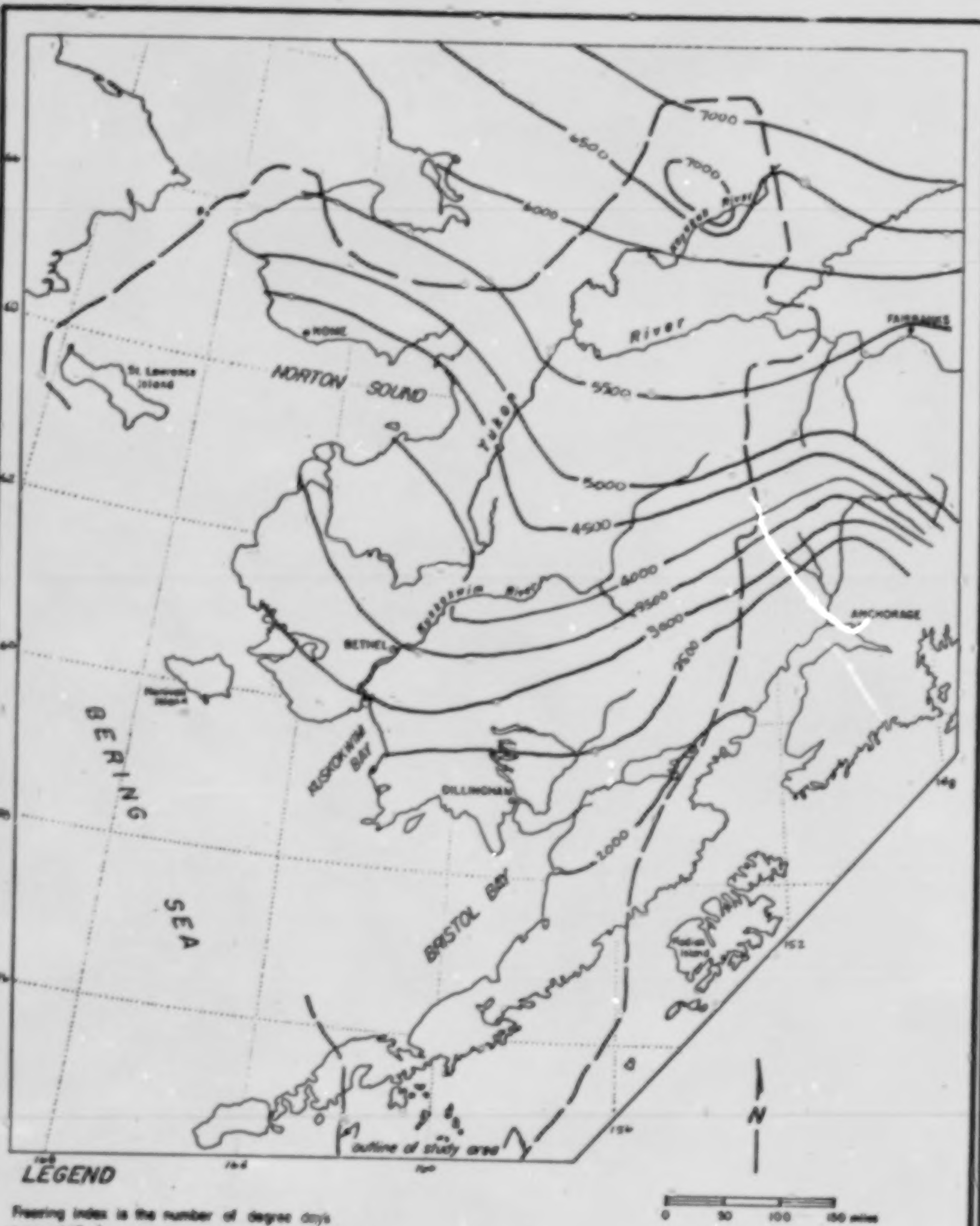
FIGURE 2.4


80°
90°
70°
NORTON SOUND
Yukon
River
90°
80°
BERING SEA
BRISTOL BAY
outline of study area
N
LEGEND
degrees Farenheit

EXTREME MAXIMUM TEMPERATURES

from Fed-St LUPC Regional Profiles

FIGURE 2.5


7000
6500
7000
6000
River
FAIRBANKS
NOME
St. Lawrence Island
HORTON SOUND
5500
Yukon
5000
4500
4000
Kuskokwim River
3500
3000
2500
BETHEL
ANCHORAGE
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
2000
BRISTOL BAY
Kodiak Island
N
outline of study area
0
50
100
150 miles

LEGEND

Freezing index is the number of degree days below 32° for one year. Add 1000 degree days for design.

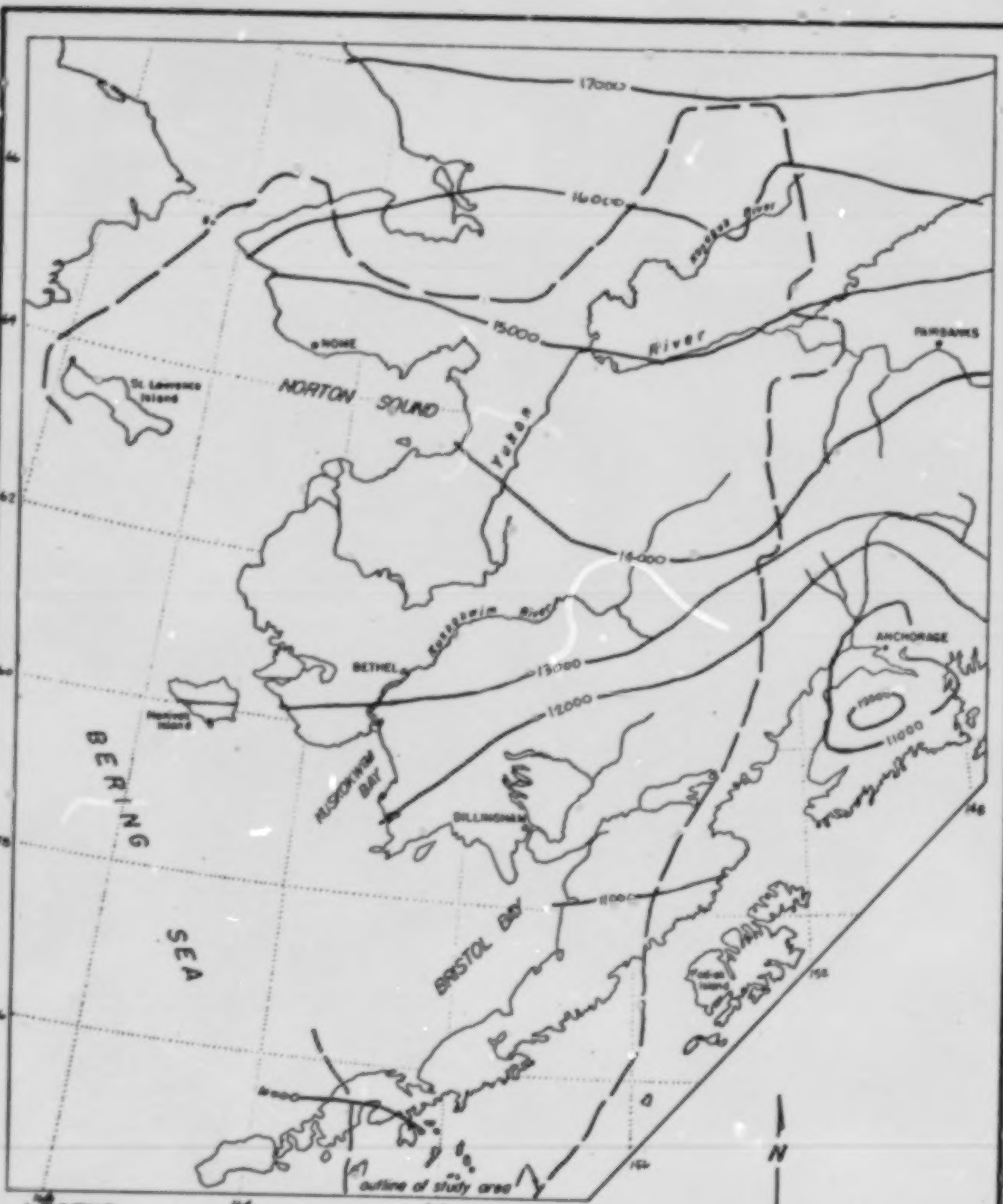
Note: Data is generally from low lying coastal and river valley areas. It is not valid for higher elevations.

FREEZING DEGREE DAYS
in Western Alaska

from Environmental Atlas of Alaska 1969

FIGURE 2.6

Section 2.0 / Page 21 d 52


17000
16000
15000
14000
13000
12000
11000
11000
11000
12000
9000
NOME
NORTON SOUND
St. Lawrence Island
Yukon
River
Koyukuk River
FAIRBANKS
ANCHORAGE
BETHEL
Kuskokwim River
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
BRISTOL BAY
Kodiak Island
outline of study area
N
66
64
62
60
58
56
168
164
160
156
152
148
0
50
100
150 miles

LEGEND

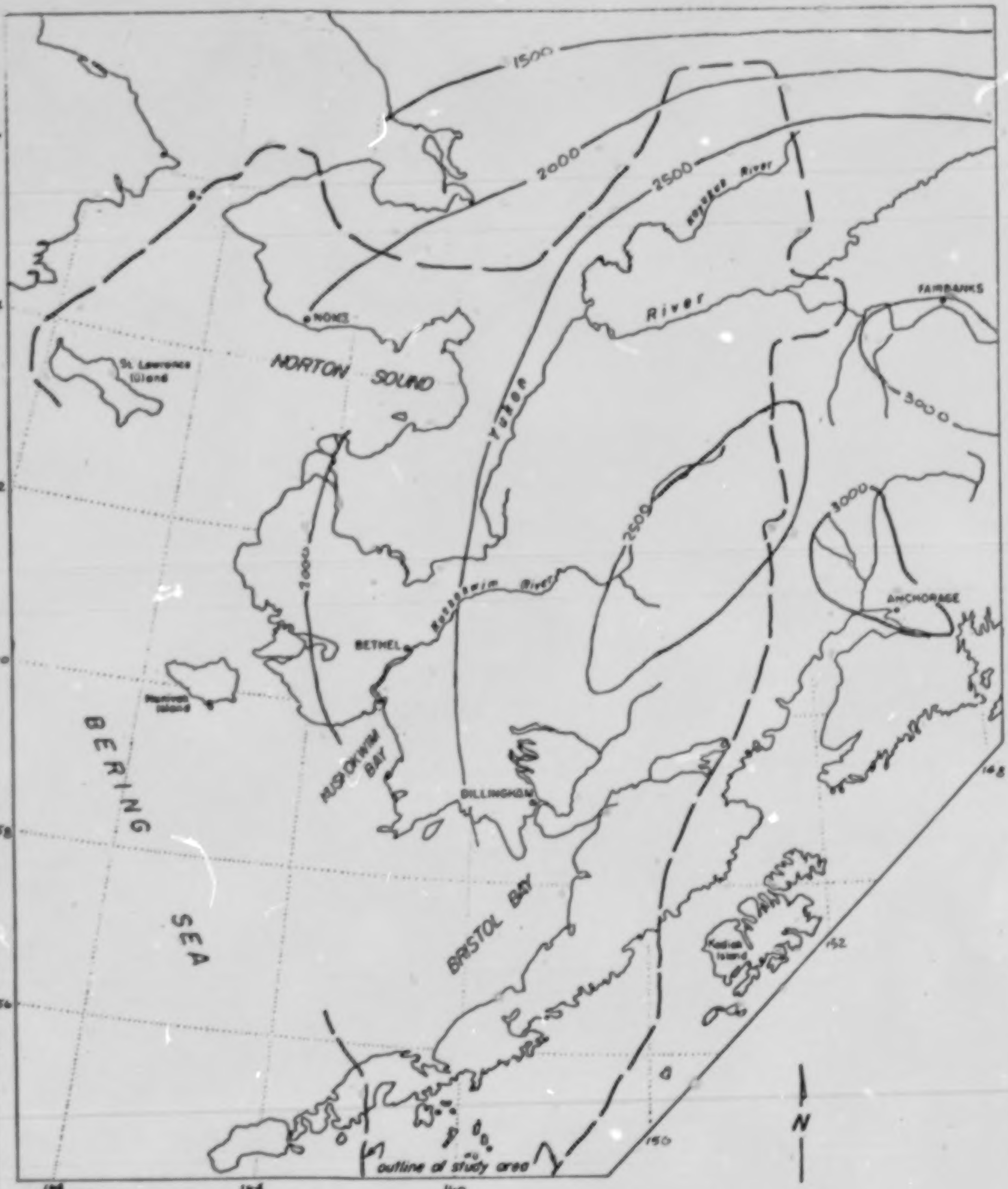
Heating degree days are the number of degree days below 65° F for one year. Add 1000 degree days for design.

Note: Data is generally from low lying coastal and river valley areas, and probably not valid for higher elevations.

HEATING DEGREE DAYS
in Western Alaska

from Environmental Atlas of Alaska 1969

FIGURE 2.7


1500
2000
2500
3000
NOME
NORTON SOUND
St. Lawrence Island
Yukon River
Koyukuk River
FAIRBANKS
Kuskokwim River
BETHEL
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
BRISTOL BAY
Kodiak Island
ANCHORAGE
outline of study area
N
66
62
60
58
56
168
164
160
152
150
148
0
50
100
150 miles

LEGEND

Thawing index is the number of degree days above 32° F for one year. Add 300 degree days for design.

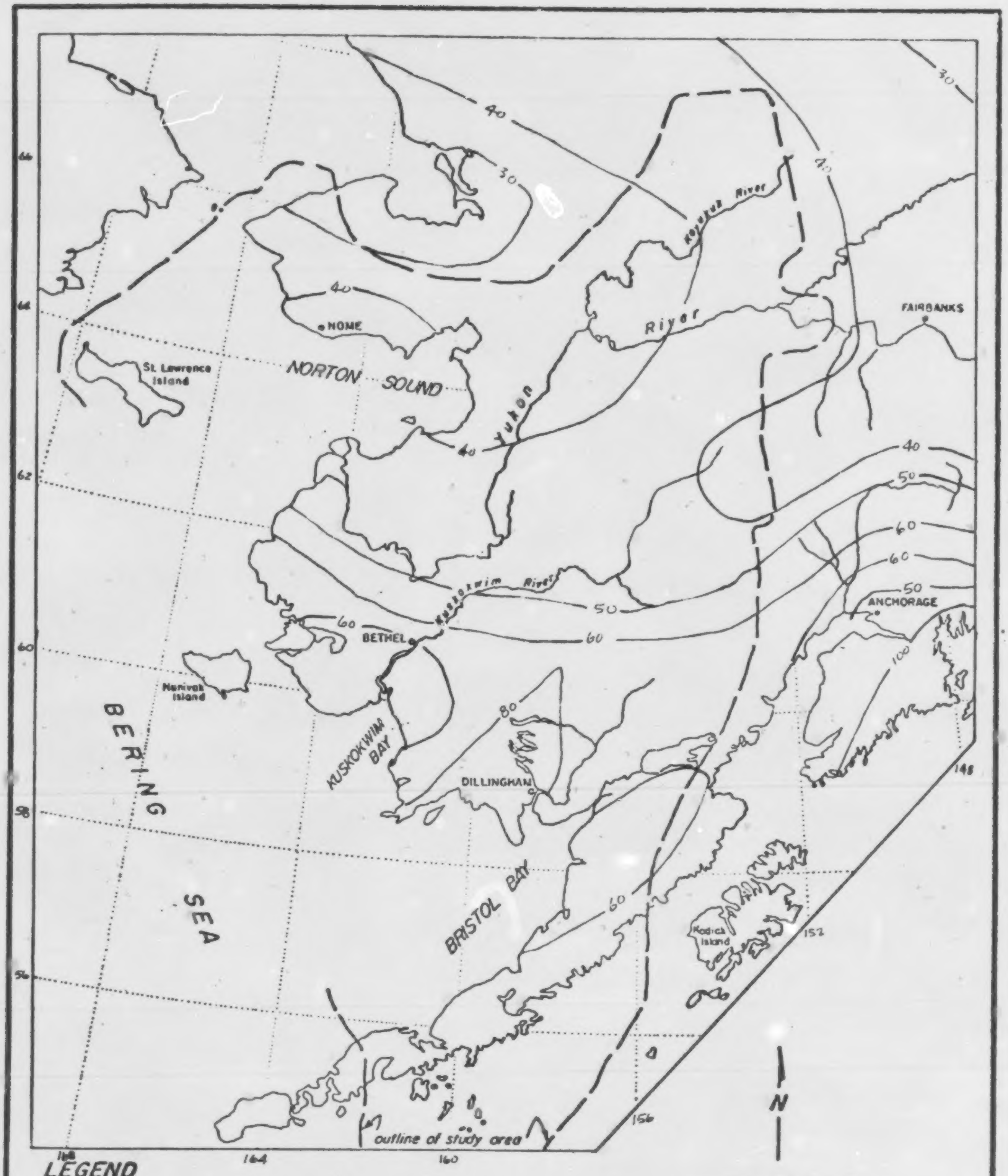
Note: Data is generally from low lying coastal and river valley areas and is probably not valid for higher elevations.

THAWING DEGREE DAYS
in Western Alaska

from Environmental Atlas of Alaska 1969

FIGURE 2.8

Section 2.0/Page 21f-


30
40
30
Koyukuk River
40
40
NOME
FAIRBANKS
Yukon River
St. Lawrence Island
NORTON SOUND
40
66
64
62
60
58
56
40
50
60
60
50
ANCHORAGE
Kuskokwim River
50
60
60
BETHEL
100
Nunivak Island
BERING SEA
80
KUSKOKWIM BAY
DILLINGHAM
148
BRISTOL BAY
60
Kodiak Island
152
156
N
outline of study area
168
164
160
0 50 100 150 miles

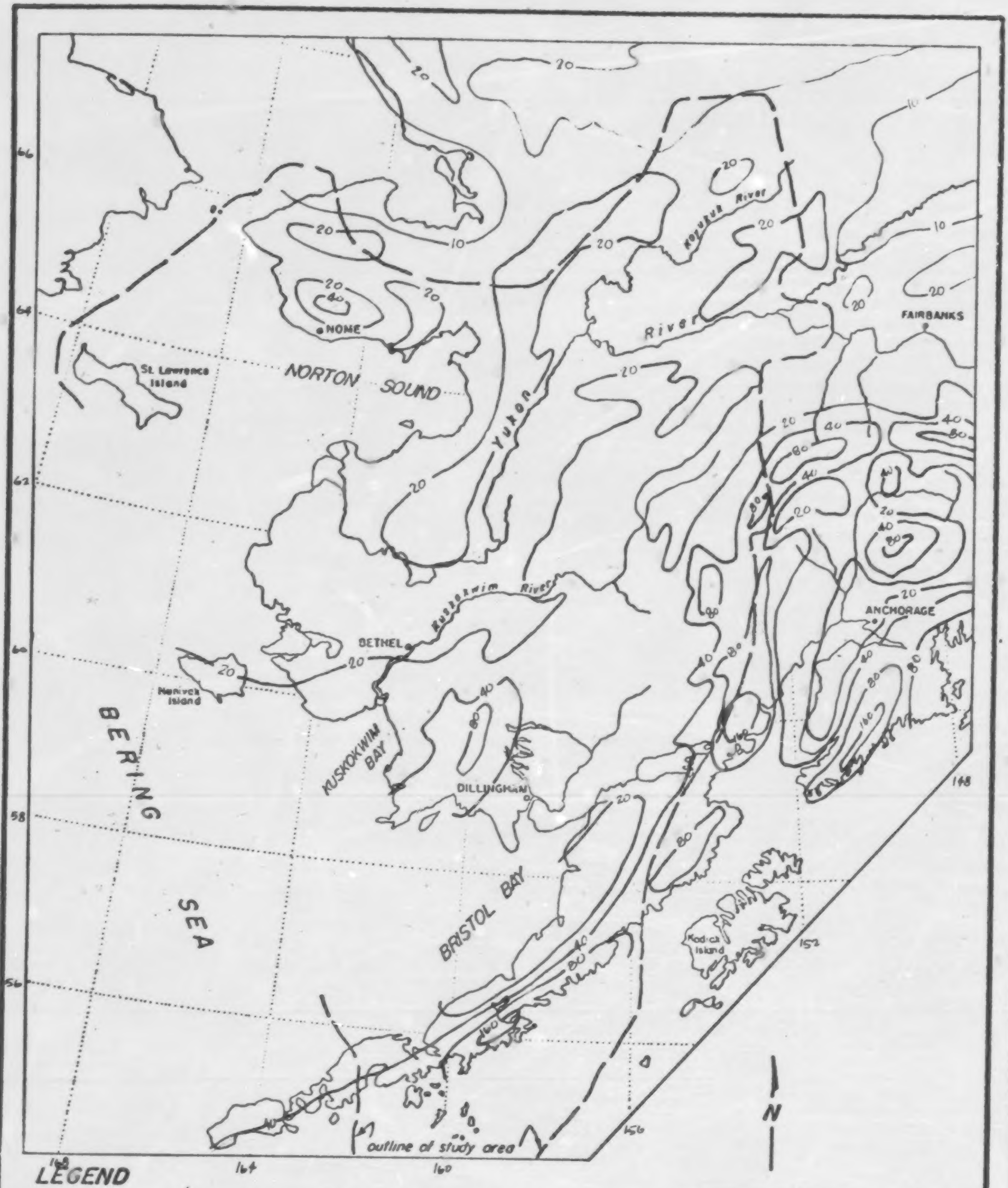
LEGEND

A wet day has 0.1 inch or more of water precipitation.

WET DAYS PER YEAR
in Western Alaska

from Environmental Atlas of Alaska 1969

FIGURE
2.9


20
10
NOME
St. Lawrence Island
NORTON SOUND
Yukon
River
Koyukuk River
FAIRBANKS
ANCHORAGE
Kuskokwim River
BETHEL
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
BRISTOL BAY
Kodiak Island
40
80
160
66
64
62
60
58
56
168
164
160
156
152
148
N
outline of study area
0
50
100
150 miles

LEGEND

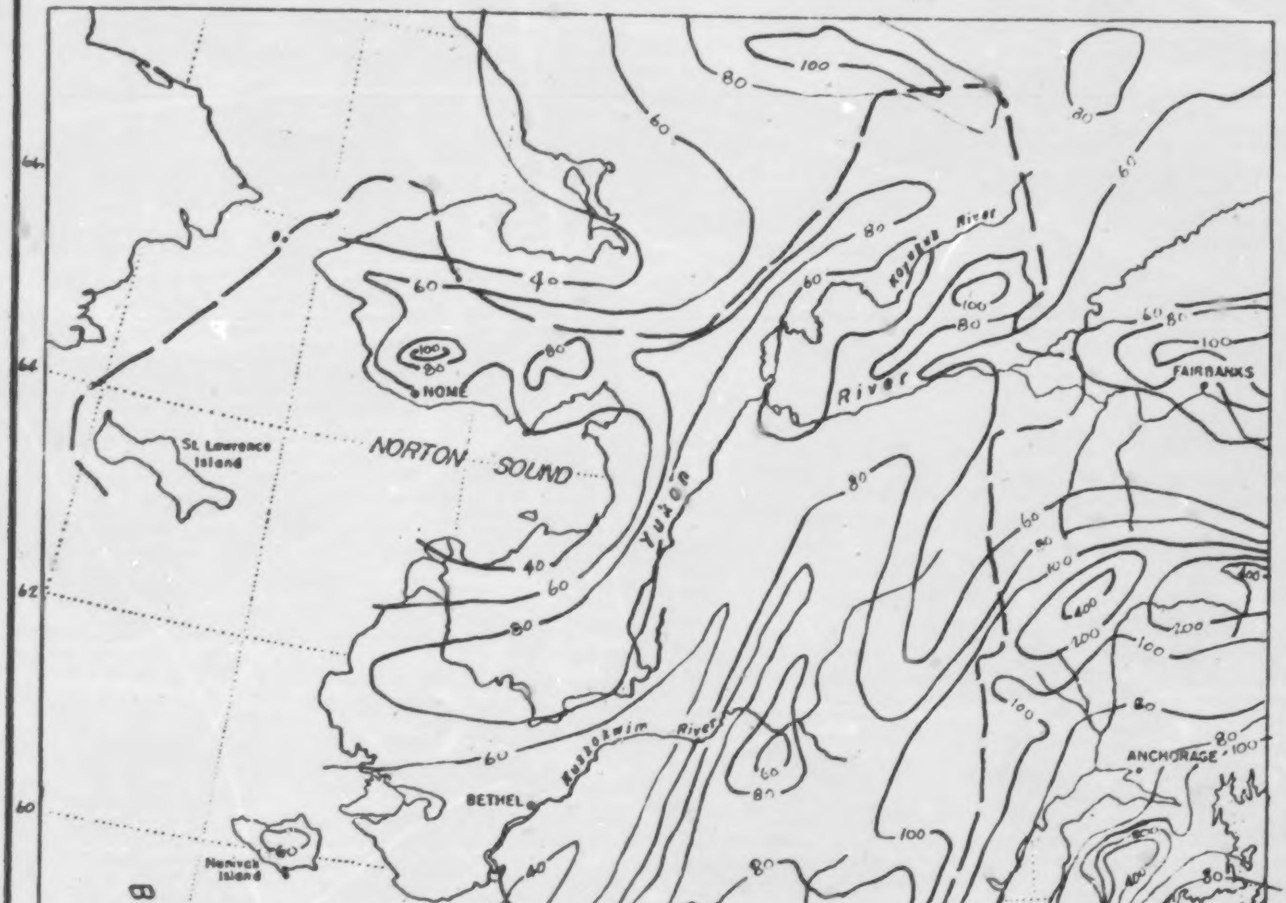
precipitation in inches of water

MEAN ANNUAL PRECIPITATION
in Western Alaska

from LUPC Regional Profiles 1974

FIGURE
2.10

Section 2.01 Page 21 h.



100
80
60
40
NOME
NORTON SOUND
St. Lawrence Island
Yukon
River
Koyukuk River
FAIRBANKS
ANCHORAGE
200
400
Kuskokwim River
BETHEL
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
BRISTOL BAY
Kodiak Island
outline of study area
N
0
50
100
150 miles
64
62
60
58
56
168
164
160
156
152
148

LEGEND

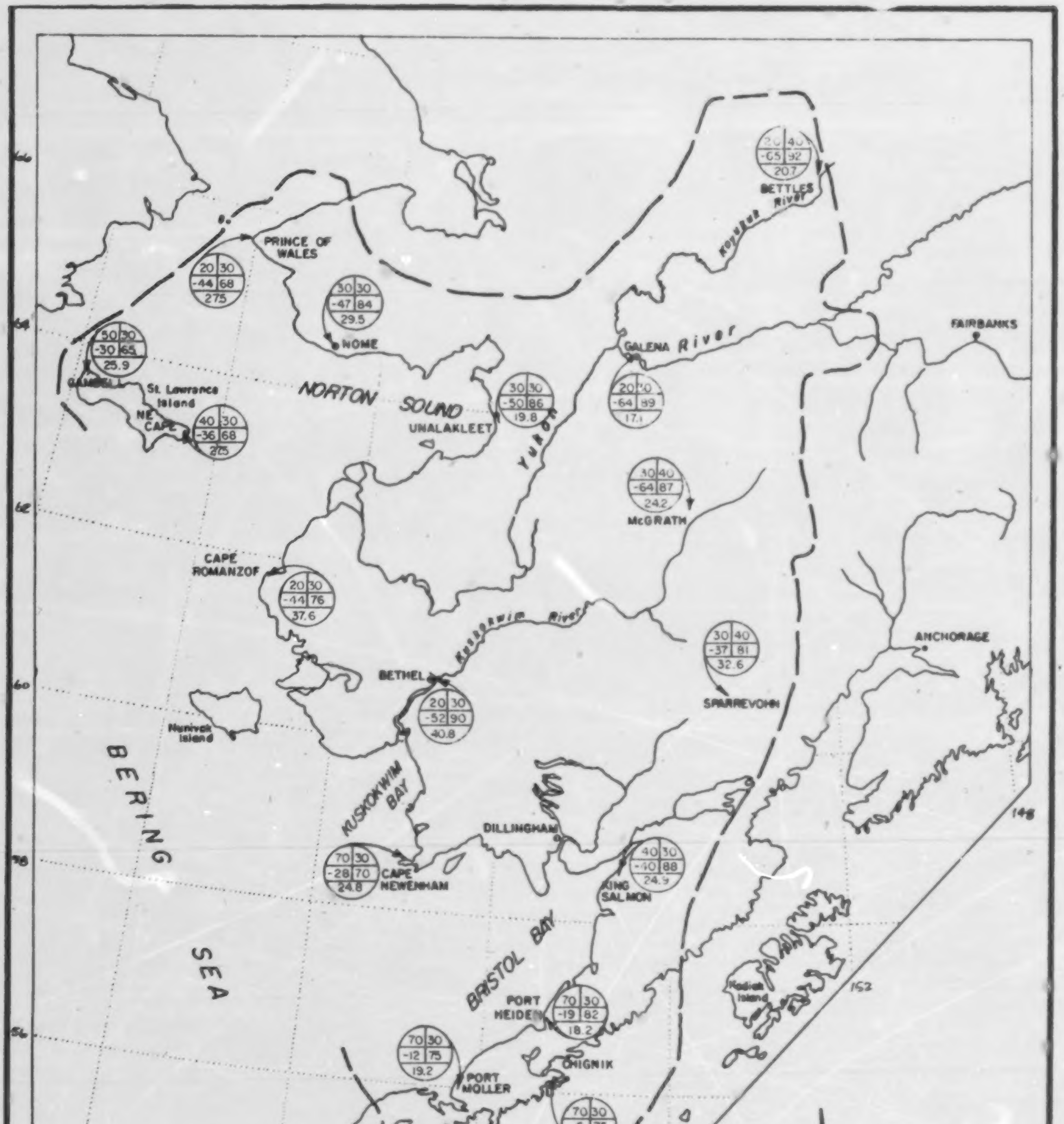
snow fall in inches of snow

10 inches snow ≈ 1 inch of water

SNOWFALL DISTRIBUTION in Western Alaska

from LUPC Regional Profiles 1974

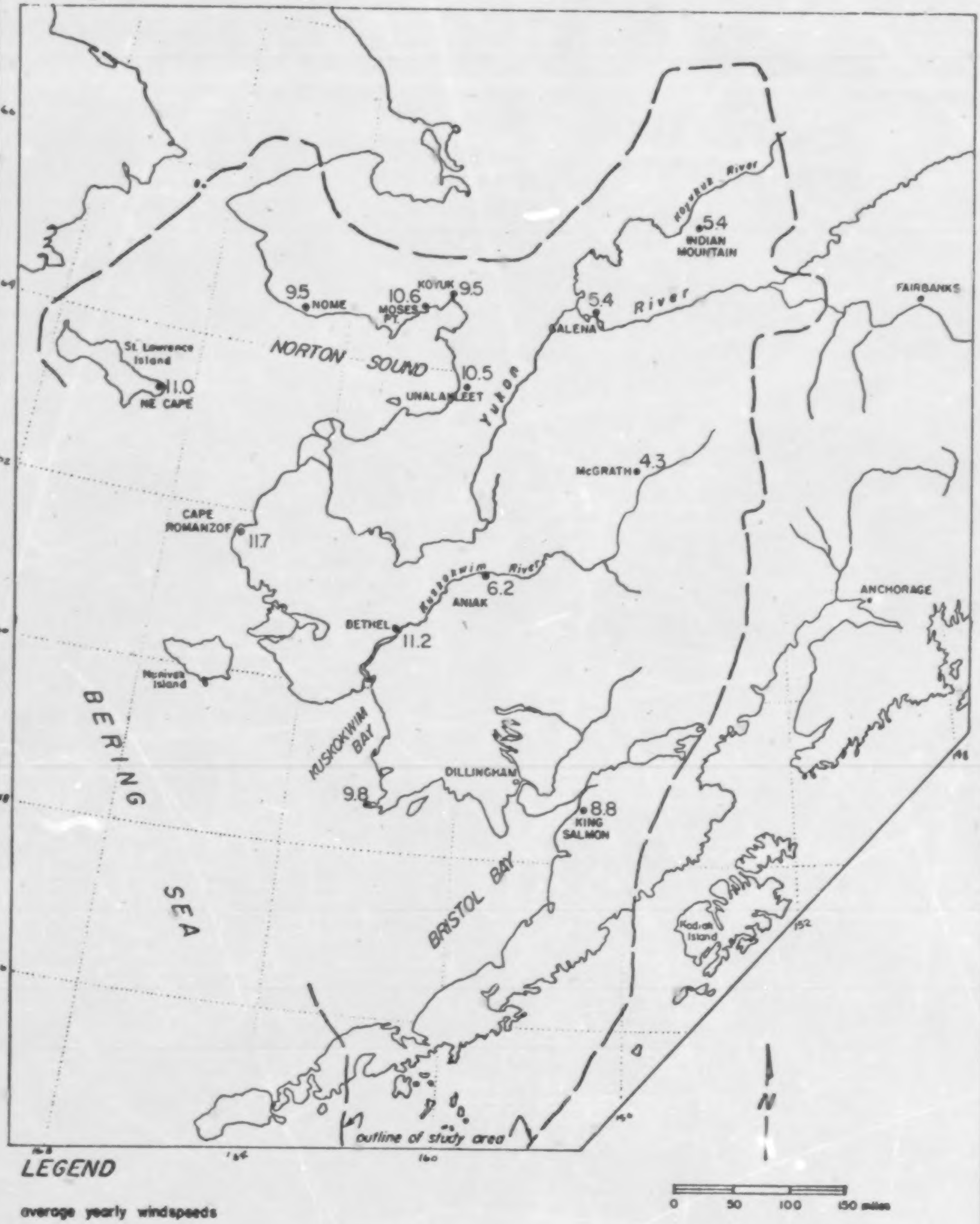
FIGURE 2.11


66
64
62
60
58
56
168
164
160
156
152
148
PRINCE OF WALES
20 30 -44 68 27.5
30 30 -47 84 29.5
NOME
50 30 -30 65 25.9
GAMBELL
St. Lawrence Island
NE CAPE
40 30 -36 68 27.5
NORTON SOUND
UNALAKLEET
30 30 -50 86 19.8
YUKON
GALENA
River
20 20 -64 89 17.1
20 40 -65 92 20.7
BETTLES
Koyukuk River
FAIRBANKS
30 40 -64 87 24.2
McGRATH
CAPE ROMANZOF
20 30 -44 76 37.6
Kuskokwim River
30 40 -37 81 32.6
SPARREVOHN
ANCHORAGE
BETHEL
20 30 -52 90 40.8
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
70 30 -28 70 24.8
CAPE NEWENHAM
40 30 -40 88 24.9
KING SALMON
BRISTOL BAY
Kodiak Island
PORT HEIDEN
70 30 -19 82 18.2
70 30 -12 75 19.2
PORT MOLLER
CHIGNIK
70 30 -6 75 17.2
outline of study area
N
0 50 100 150 miles
LEGEND
design wind load, psf
design snow load, psf
extreme min. temp., °F
extreme max. temp., °F
max. annual precipitation
40 30 -40 82 19.7

BUILDING DESIGN CRITERIA
in Western Alaska

from Environmental Atlas of Alaska 1969

FIGURE 2.12


9.5 NOME
10.6 MOSES PT.
KOYUK 9.5
NORTON SOUND
St. Lawrence Island
11.0 NE CAPE
10.5 UNALAKLEET
Yukon River
5.4 GALENA
Koyukuk River
5.4 INDIAN MOUNTAIN
FAIRBANKS
McGRATH 4.3
CAPE ROMANZOF 11.7
Kuskokwim River
6.2 ANIAK
BETHEL 11.2
Nunivak Island
BERING SEA
KUSKOKWIM BAY
9.8
DILLINGHAM
8.8 KING SALMON
BRISTOL BAY
ANCHORAGE
Kodiak Island
outline of study area
N
0 50 100 150 miles
66
64
62
60
58
56
168
164
160
156
152
148

LEGEND

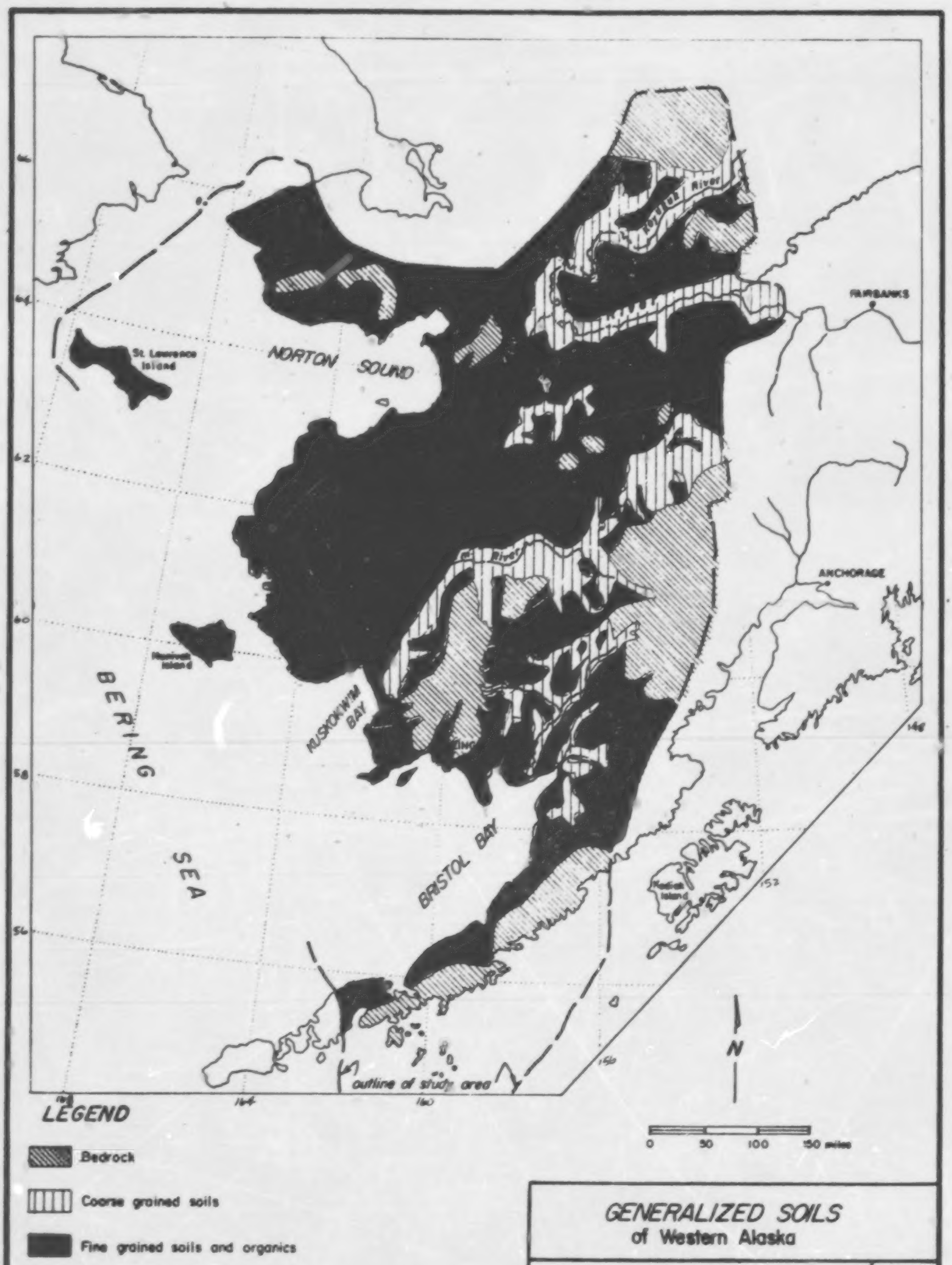
average yearly windspeeds
in knots

AVERAGE WIND SPEEDS
in Western Alaska

from AEIDC Weather Information Service

FIGURE 2.13

Section 2.0/ Page 21 k. 57

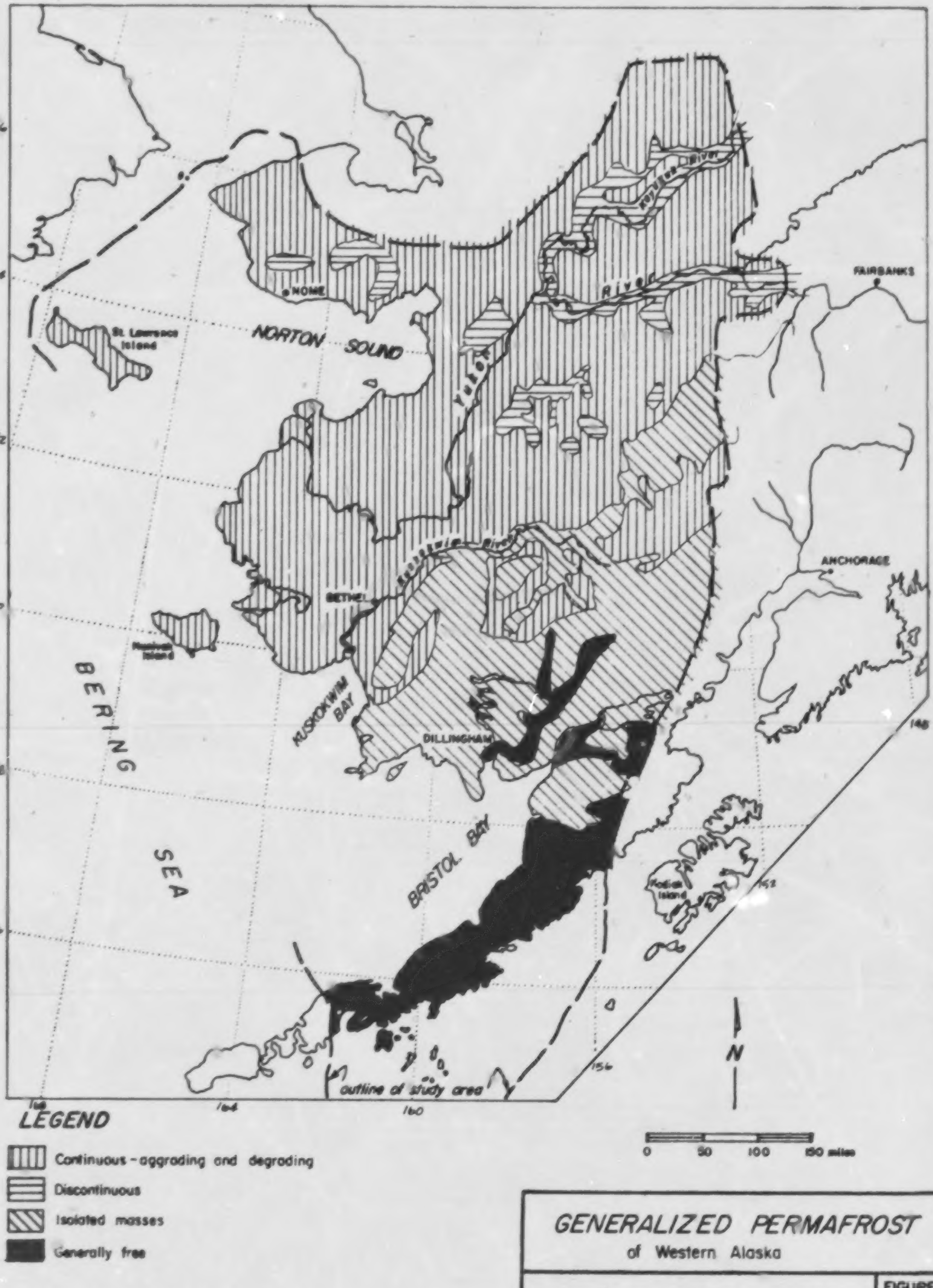

66
64
62
60
58
56
168
164
160
156
152
148
St. Lawrence Island
NORTON SOUND
Koyukuk River
River
FAIRBANKS
ANCHORAGE
Nunivak Island
BERING SEA
KUSKOKWIM BAY
BRISTOL BAY
Kodiak Island
outline of study area
N
0
50
100
150 miles
LEGEND
Bedrock
Coarse grained soils
Fine grained soils and organics

GENERALIZED SOILS
of Western Alaska

from "Permafrost Map of Alaska"
USGS Map I-445

FIGURE
2.14

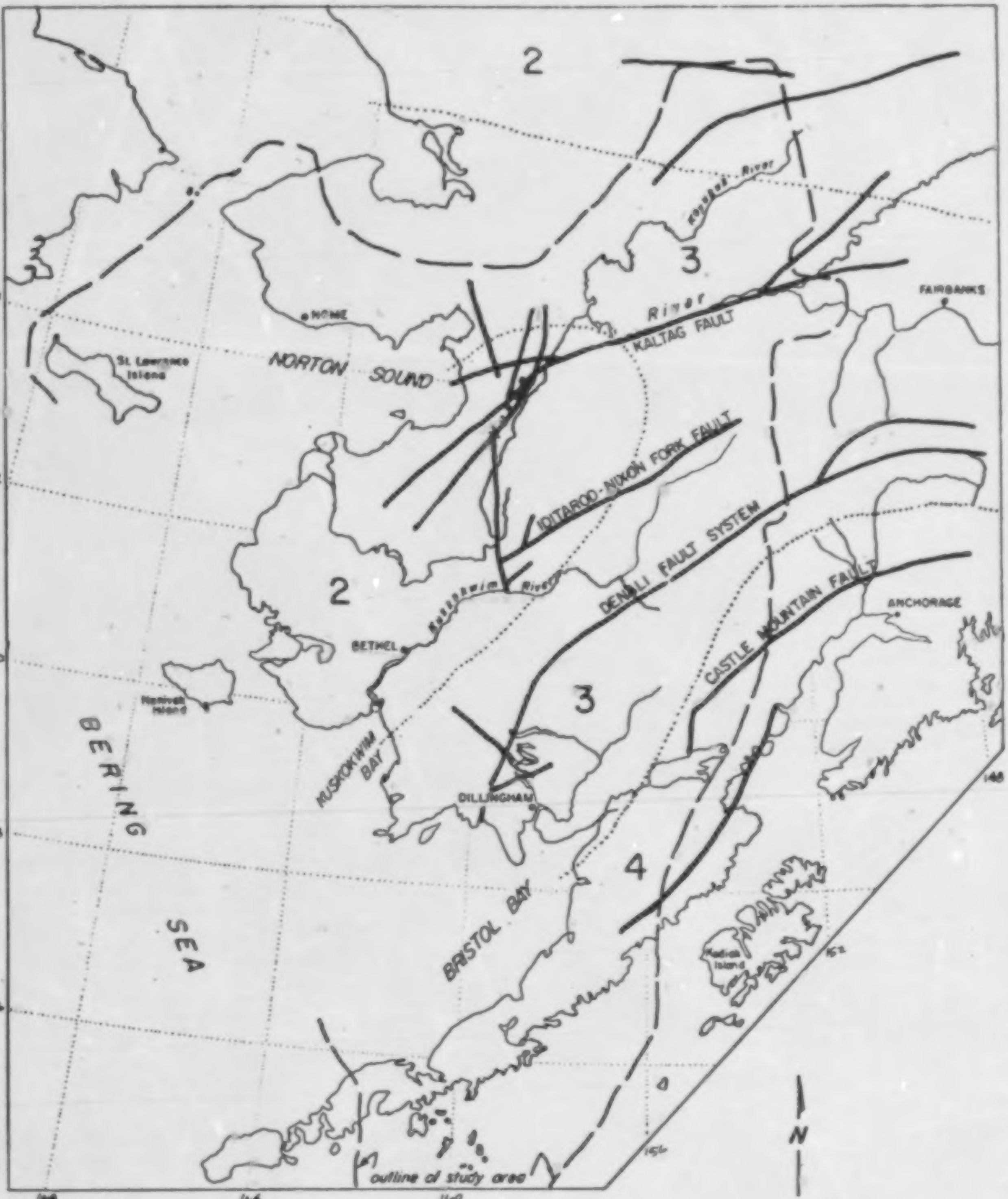
Section 2.0 / Page 21 1. 60


NOME
NORTON SOUND
St. Lawrence Island
Yukon River
Koyukuk River
FAIRBANKS
BETHEL
Kuskokwim River
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
BRISTOL BAY
ANCHORAGE
Kodiak Island
outline of study area
N
66
64
62
60
58
56
168
164
160
156
152
148
LEGEND
Continuous - aggrading and degrading
Discontinuous
Isolated masses
Generally free
0
50
100
150 miles

GENERALIZED PERMAFROST
of Western Alaska

from "Permafrost Map of Alaska"
USGS Map I-445

FIGURE 2.15


2
NOME
St. Lawrence Island
NORTON SOUND
Koyukuk River
3
River
KALTAG FAULT
FAIRBANKS
IDITAROD-NIXON FORK FAULT
DENALI FAULT SYSTEM
2
Kuskokwim River
BETHEL
Nunivak Island
CASTLE MOUNTAIN FAULT
ANCHORAGE
3
BERING
KUSKOKWIM BAY
DILLINGHAM
4
BRISTOL BAY
SEA
Kodiak Island
N
outline of study area
66
64
62
60
58
56
168
164
160
156
152
148
0 50 100 150 miles

LEGEND

Major fault or lineal feature

Seismic risk zone

2 Moderate structural damage (4.3 - 6.0 on Richter scale)

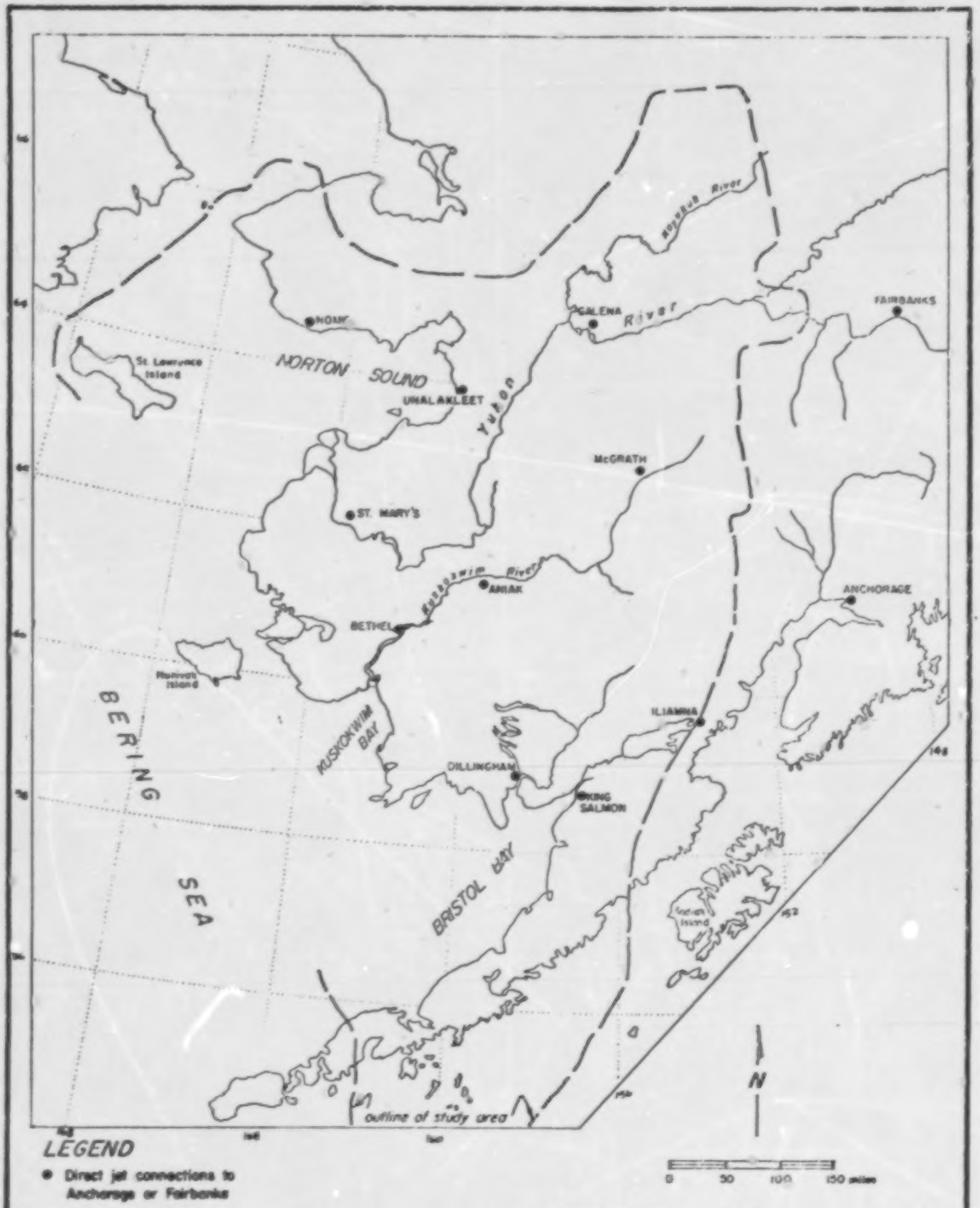
3 Major structural damage (greater than 6.0)

4 Potential damage is greater than zone three due to geologic and tectonic factors

SEISMICITY in Western Alaska

from LUPC Yukon Regional Profile 1974

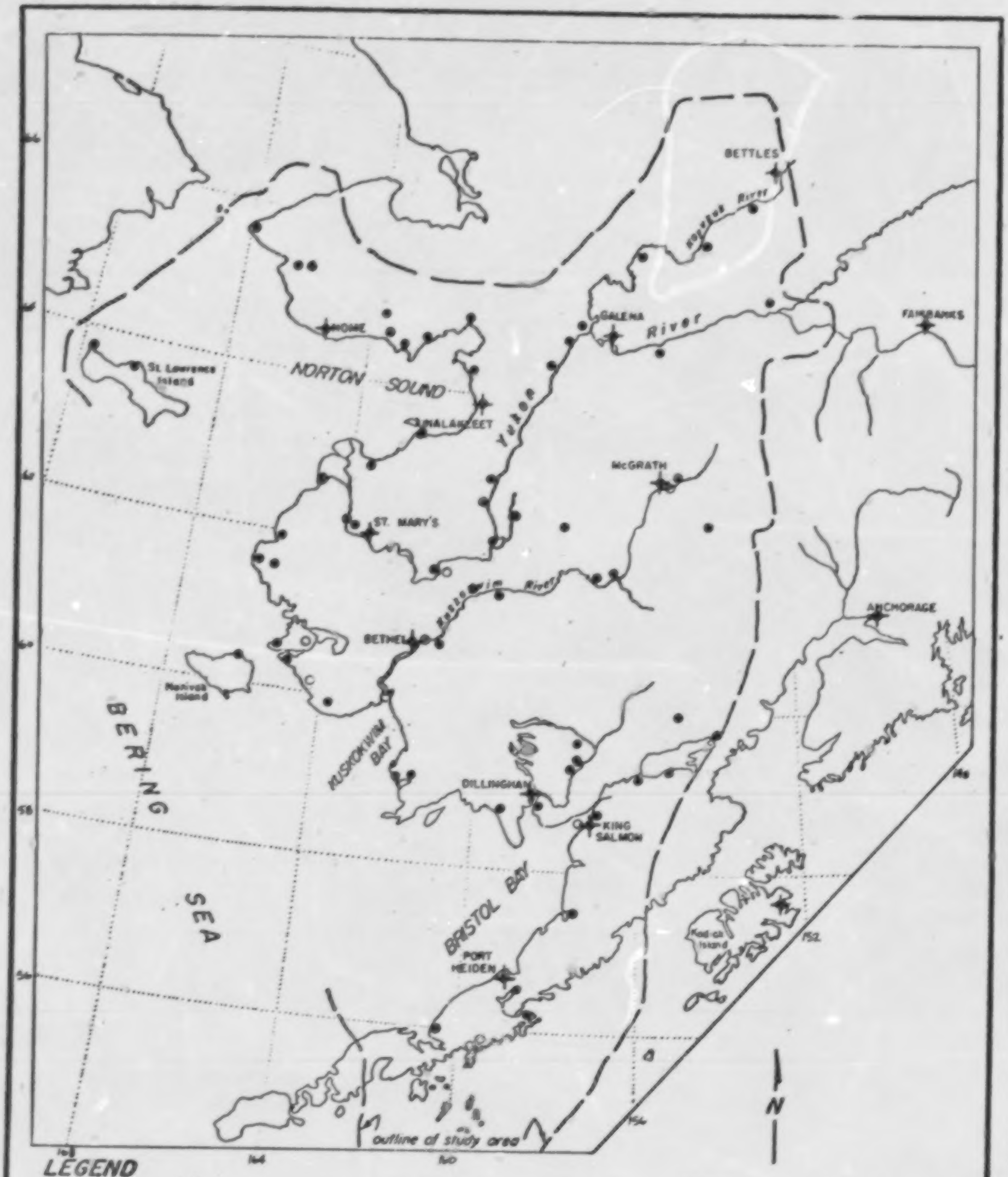
FIGURE 2.16


NOME
GALENA
Koyukuk River
River
FAIRBANKS
St. Lawrence Island
NORTON SOUND
UNALAKLEET
Yukon
McGRATH
ST. MARY'S
Kuskokwim River
ANIAK
ANCHORAGE
BETHEL
Nunivak Island
BERING
ILIAMNA
KUSKOKWIM BAY
DILLINGHAM
KING SALMON
SEA
BRISTOL BAY
Kodiak Island
outline of study area
N
0 50 100 150 miles
LEGEND
● Direct jet connections to Anchorage or Fairbanks

COMMERCIAL AIR CONNECTIONS in Western Alaska

source: Wein Air Alaska 1978

FIGURE 2.17


BETTLES
Koyukuk River
FAIRBANKS
GALENA
Yukon River
NOME
NORTON SOUND
St. Lawrence Island
UNALAKLEET
McGRATH
ST. MARY'S
Kuskokwim River
BETHEL
ANCHORAGE
Nunivak Island
BERING SEA
KUSKOKWIM BAY
DILLINGHAM
KING SALMON
BRISTOL BAY
PORT HEIDEN
Kodiak Island
outline of study area
N
0 50 100 150 miles
168
164
160
156
152
148
66
64
62
60
58
56

LEGEND

- ✦ Over 5000 feet long
- ● 2000 - 5000 feet
- ○ Seaplane base

LANDING STRIPS
in Western Alaska

source: U.S. Government 1978
Flight Information Publication

FIGURE
2.18

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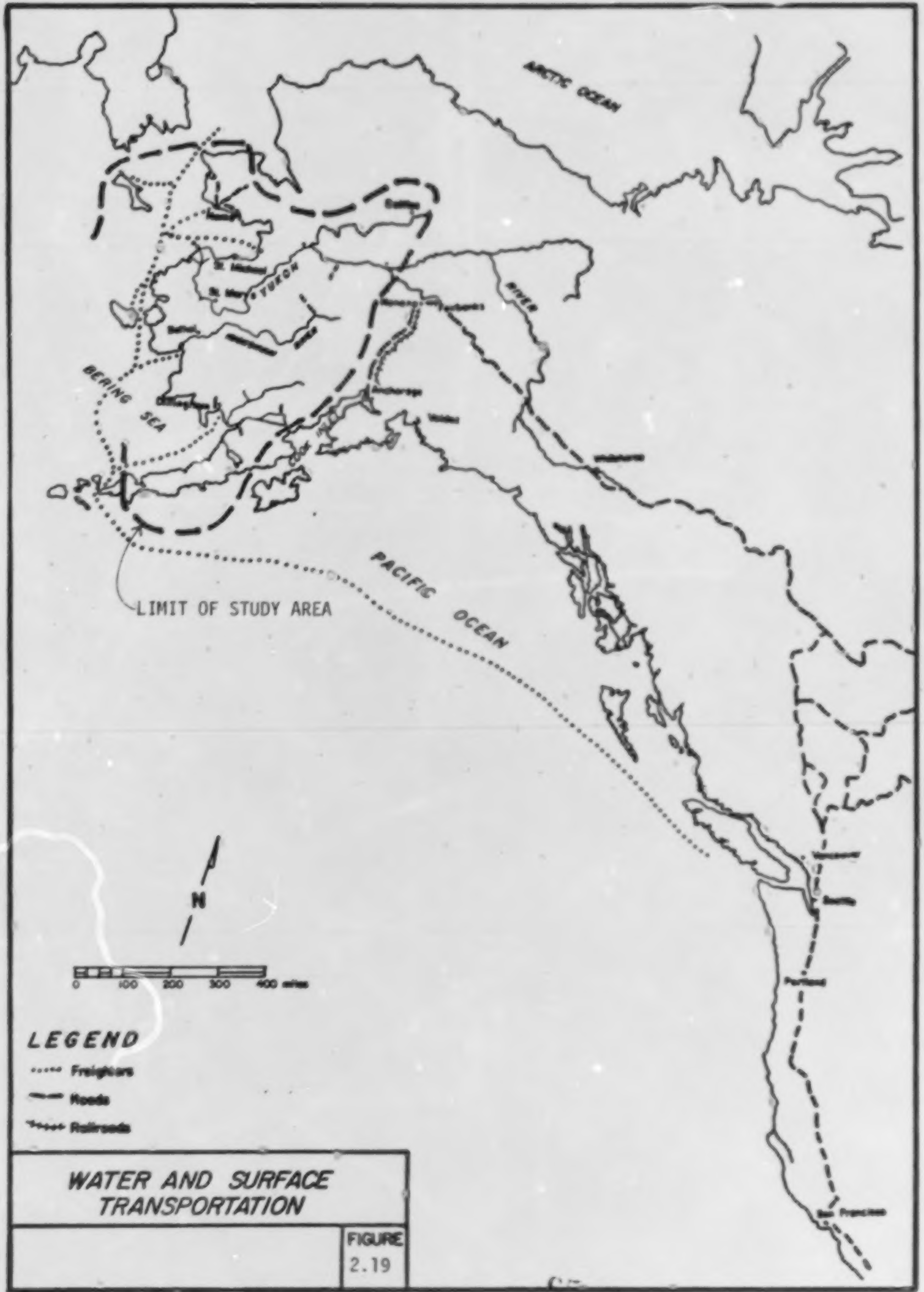
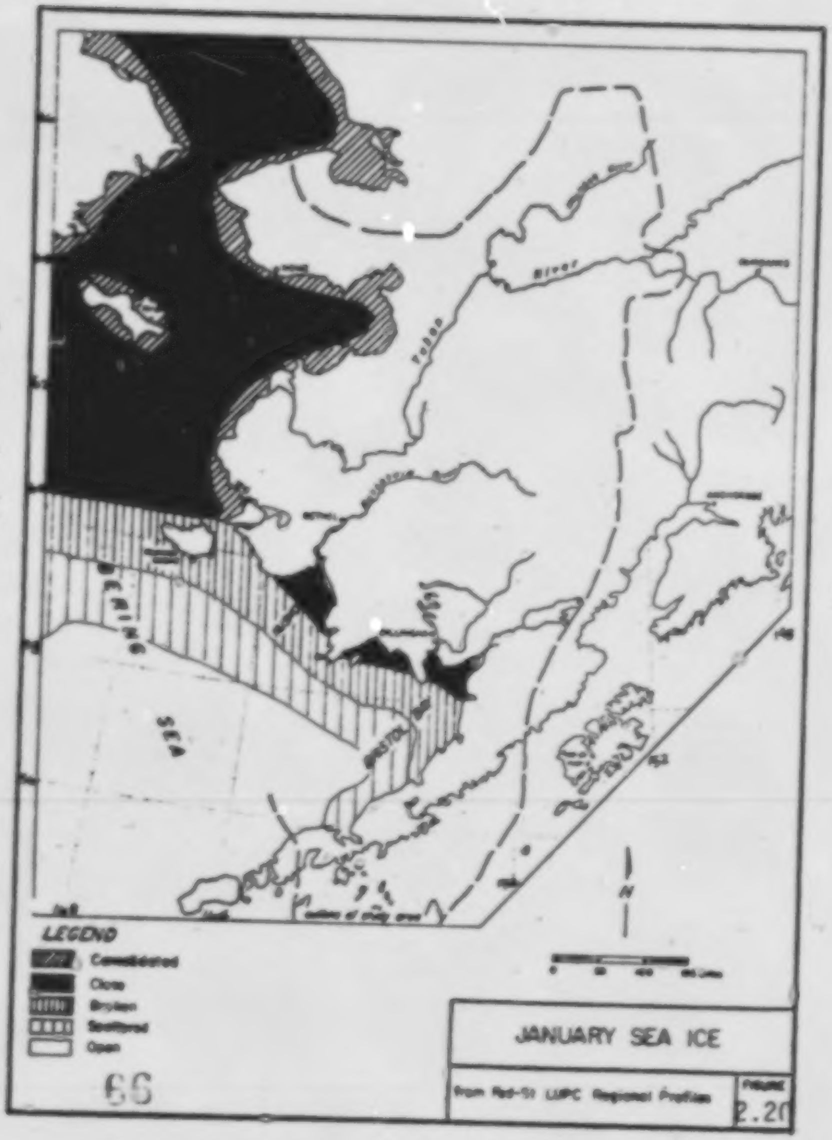

ARCTIC OCEAN
St. Michael
St. Mary's
YUKON
RIVER
Fairbanks
Anchorage
BERING SEA
PACIFIC OCEAN
LIMIT OF STUDY AREA
Vancouver
Seattle
Portland
San Francisco
N
0
100
200
300
400 miles
LEGEND
Freighters
Roads
Railroads

WATER AND SURFACE TRANSPORTATION

FIGURE 2.19

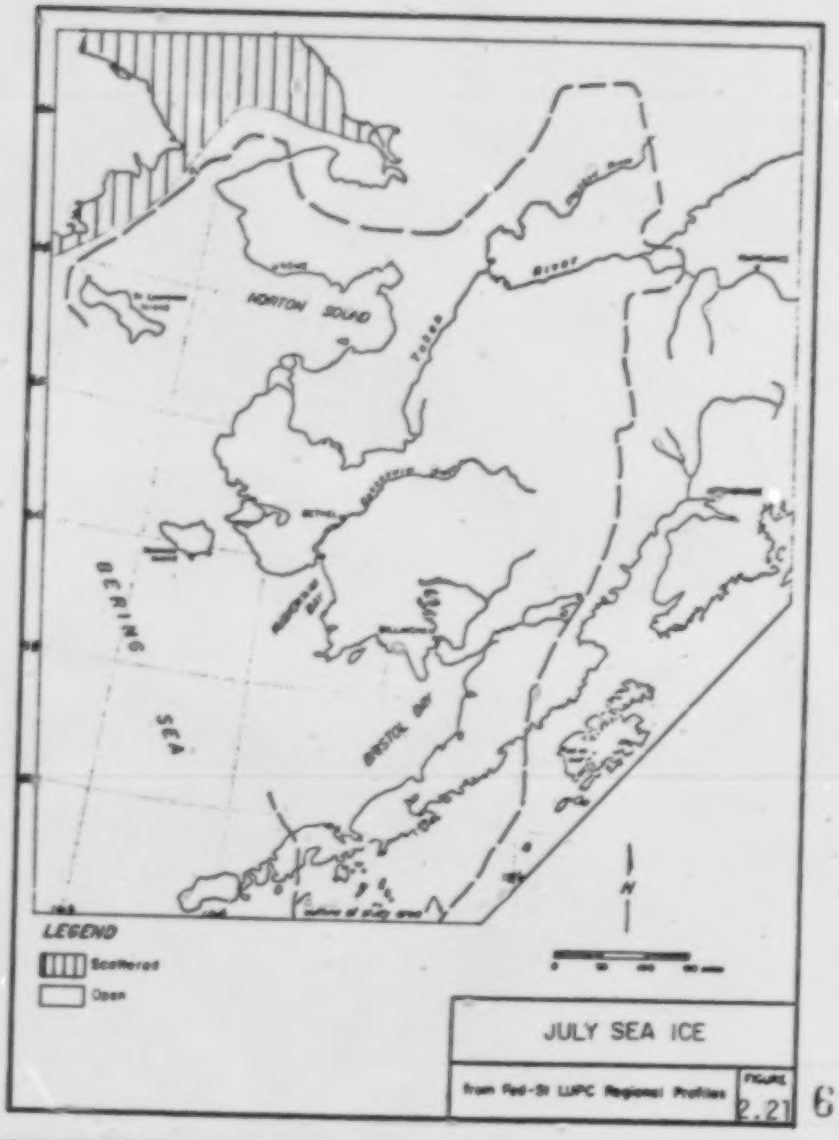
Section 2.0/ Page 21 r


BERING SEA
BRISTOL BAY
Yukon River
LEGEND
▨ Consolidated
■ Close
▥ Broken
▤ Scattered
☐ Open
N

JANUARY SEA ICE

from Fed-St LUPC Regional Profiles

FIGURE 2.20


NORTON SOUND
BERING SEA
BRISTOL BAY
Yukon River
LEGEND
▥ Scattered
☐ Open
N

JULY SEA ICE

from Fed-St LUPC Regional Profiles

FIGURE 2.21

SECTION CONTENTS

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LIST OF ILLUSTRATIONS USED IN THIS SECTION:

Figure 3.1 Thermal Springs and Coal Resources

SECTION 3.0 SITE UTILITIES DETERMINANTS

INTRODUCTION:

Site utilities consist of those functions that provide long-term habitable environments, i.e., water supply, waste water disposal, solid waste disposal, fuel, and electric power. The size of these utilities range from those for single occupant usage to full community service. In arctic and sub-arctic regions, these site utilities are subjected to severe environmental conditions not found in more temperate regions.

The range of determinants listed below covers the conditions that are expected to be encountered where new secondary schools are proposed to be built in the villages. In some cases, an existing system may provide the needed utilities, and all that is required is to make a service connection to that existing utility. In some locations, the utilities for a new school may have to be built in their entirety. An example would be providing a new well and water treatment system to supply water to a new school building.

Each utility is listed below with the determinants that affect them, together with the considerations that must be made under each determinant.

The various utilities are affected in various degrees by the environmental determinants which are identified in Section 2.0 of this report. Water and waste water utilities are particularly affected by environmental determinants and these are mentioned again in the following discussion.

3.1 WATER:

3.11 Existing System:

Considerations:

The existing water supply system may consist of a complete pressurized, circulating, piped system that is insulated and has enough capacity to accept service connections. Existing systems may also consist of a watering point or a variety of possibilities which lie between that and a conventional city system. The primary concern will be to determine if the existing system has the ability to serve the proposed school facility. Often, existing water systems are sized for present day needs and not for future needs, such as a new secondary school may imply. With those conditions, agreements have to be reached between the school district and village to provide either additional storage, or some means of augmenting the existing supply. In any case, whether it would be to tap into an existing distribution system or to add storage tanks, agreements are required between the school district and the owner of the existing system.

Another consideration when connecting to an existing water system is the method of connecting to the existing utility to avoid freeze-ups and leakage. The quality of water from an existing system should also be determined so that the need for any additional treatment may be ascertained. The rate of flow and pressure available in the existing system may determine what additional storage may be necessary within the school building.

3.12 Identification of Potential Sources:

Considerations:

1. Surface Water: Surface water, as a source for potable water, may consist of a natural lake or stream, water that occurs in the ground above 30 feet from the ground surface, or rain water or snow gathered by collectors such as lagoons or roofs. Sea or lake ice, in season, may also be considered as a surface water supply.

   Recovery systems for surface water supplies are affected by environmental determinants such as freezing, permafrost, flooding, and soil conditions. For example, water that is to be recovered from a surface source such as a lake will be affected greatly by freezing conditions. The intake structure and pump will have to be protected from icing conditions, as will any pipe which leads to a storage tank or treatment plant. The ice that forms on a lake may severely restrict the amount of water available during winter months. Freezing of water also tends to contaminate it. Those solids which are dissolved in normal surface waters are forced by freezing to be concentrated in the remaining fluid. The use of such concentrated water is possible, but often requires extensive treatment before it becomes of a quality that is usable for potable water.

2. Groundwater: Groundwater is water which lies below 30 feet from the surface and is usually recovered from some form of well by pumping. Some groundwater is found in a confined state which, when tapped, is termed as being artesian. This means that the pressure on the water from some external force is sufficient to raise the water in a well to a point above the level of the aquifer in which the water is found.

   A groundwater source is vulnerable to freezing conditions when it is tapped by a well. Those parts of the well near the surface are subject to freezing during winter, and those water sources which are located deep in the ground are, in addition, subject to permafrost freezing conditions as they are extracted from the ground. Both the temperature of the groundwater and that of the surrounding permafrost are vital pieces of information for the designer.

3.13 Report on Water Quality Characteristics:

Considerations:

1. Color/Taste/Odor: Color, taste, and odor of water in many village locations may be beyond tolerable limits in the existing or proposed water supply. In the Alaska Drinking Water Standards, for example, the maximum contaminant concentration allowed for color is 30 units and applies only to groundwater sources. Turbidity, which is a measure of water clarity, is similarly limited to one unit on the average over a period of one month. The qualities of odor and taste are not addressed in the Alaska Drinking Water Standards. Even though color, taste, and odor of a water source may not bring a rejection of a water source, the chemical quality of the water that is associated with these characteristics may be cause to reject a water source.

2. Chemical Content: Maximum contaminant concentrations for drinking water are also listed in the Alaska Standards. Chemical contaminants are divided between inorganic and organic characteristics. Examples of allowable contaminant concentrations are: arsenic - 0.05 mg/l (milligrams per liter); iron - 0.3 mg/l; nitrate - 10.0 mg/l; and sodium - 250 mg/l. Water quality measurements, such as hardness and alkalinity, are not listed under the allowable maximum contaminant concentrations. The chemical content of the water will determine, to a large extent, what treatment will be necessary for the water to render it useful for drinking and other potable uses.

3. Biological Content: All potential water sources must be tested for bacterial contamination, as well as chemical content. The primary tests involved in determining the suitability of a water source, from a bacteriological standpoint, is to test for coliform bacteria which would indicate the presence of human wastes in the water source. To help assure that human wastes will not enter the water system, the State of Alaska has set out in their Administrative Code under Title 18, Environmental Conservation, Chapter 80, Drinking Water, the minimum separations of wells and waste water systems which must be maintained. According to this code, any size of school will require a classification of "public" on its water system. The size of the school will determine whether the system is Class A, B, or C, and what the minimum separations will be.

   Other organisms associated with human waste are also dangerous to water supply for humans. Various parasites may be present in water supplies, particularly lakes that are exposed to human and animal activities. Some of these parasites are resistant to chlorine disinfection, and the most reliable method of disposing of such parasites is by employing filtration.

3.14 Identification of Water Quantity Available:

Considerations:

The quantity of surface water available is usually dependent on the amount of precipitation available at that location, or in the area which is tributary to a stream which runs through the area. Information on seasonal and yearly variations in precipitation would be valuable in determining the suitability of using surface waters. Another determinant which is important to the use of surface water is that of ice thickness at the source. If the entire water source freezes, then some method of storage will be necessary for those times when water in a liquid form is no longer available. This type of information is available for the various areas in Alaska by consulting the Alaska Regional Profiles.

The quantity of water to be found in a groundwater source may be difficult to ascertain. If wells have been dug or drilled previously in the village, there may be records showing what soils were encountered and at what level the water was found. Groundwater information may be available for the locations by contacting the U.S. Geological Survey, U.S. Public Health Service, Alaska Department of Environmental Conservation, or the Bureau of Indian Affairs. Private establishments such as canneries or village stores may also have groundwater information.

3.15 Water Storage Need:

Considerations:

Storage requirements may be variable as the system dictates. If a good, dependable water system is available, water storage requirements may be none. If the school needs affect the pressure and flow available in a central system, then some form of storage and repressurization within the school will be needed. If the school must have its own water system, a good, dependable well may allow the system to consist of a pump within a well and a hydropneumatic tank to pressurize the system. The size of such a tank may be only large enough to handle the surges on the line.

If the water system is dependent on an intermittent source, such as a stream that freezes in the wintertime, then storage must be provided to cover those periods of time when water is not available in liquid form. In some areas, the period of time when storage is necessary may involve more than half of the year. If such storage is required, then the most important consideration is the rate of usage so the amount of storage can be estimated. Water conservation must be emphasized daily in the operation of a school.

3.16 Water Treatment Need:

Considerations:

It is a requirement of the Alaska Department of Environmental Conservation that all surface water used for drinking purposes be filtered and chlorinated as minimum treatment. Well water from depths below 30 feet from ground level will not require treatment if the water is chemically and biologically safe. Where treatment of water is required, adequate facilities for purification, and storage with a retention time that allows a residual chlorine level to be maintained, must be considered by one designing or evaluating a water system for a school. If waters contain contaminants, such treatment may be done by chemical and/or physical methods.

An important consideration is the technological capability in the village. The problems with operating such a system must be carefully considered and the operation must be explained to the owners prior to the design of such systems. Complicated water purification systems are of no value if they cannot be operated successfully in a remote location.

3.2 WASTE WATER:

3.21 Existing System:

Considerations:

Existing facilities that are in service in the villages may be utilized by the school system if the capacity is available in the system, and if agreements are obtained from the proper authority for the use of the facilities. The existing facilities may range in sophistication from a piped system with a treatment plant which offers secondary treatment, to a honey bucket system that disposes of wastes.

In some areas the sewage collection system may be a conventional gravity type, with manholes and collector lines laid into a treatment plant. In some areas, the school may be located so that all sewage must be pumped up to some disposal system. In some systems the collector pipe may be exposed "arctic" piping along the surface of the ground.

It will be necessary that the connection to any existing system be made safe environmentally by protecting service lines from freezing and physical damage. Existing facilities should be inspected on-site for location and capability. As-builts that are available of existing systems are frequently in error.

3.22 Quantity and Quality of Waste Water:

Considerations:

In order to design a waste water disposal system, the engineer should first know the amount of sewage and the constituents of the waste. The quantity of waste water is dependent, in a large part, on the amount of water available to users of the system. If water is plentiful, then more uses will be made of it for flushing, showers, and washing purposes. If the water supply is limited, then those activities that take larger amounts of water will have to be controlled.

In a secondary school which has a multipurpose room with showers and all the normal high school activities, the usage will probably go as high as 25 gallons per capita per day. In schools without showers, but with adequate water supply, the usage would be expected to be about 15 gallons a day per student. Where measures are taken to limit the use of water with such equipment as limited flush toilets, water usage could be as low as 5 gallons a day or less. When these predicted daily flows are multiplied by the number of students (up to 46 for the largest of the proposed secondary schools), the waste water quantity will still only amount to 1,000 to 1,200 gallons per day. This amount of waste water could be treated in a normal sized household-type septic tank or treatment plant. Most packaged sewage treatment plants are of a size that would handle considerably more sewage; if such plants were installed in small rural schools, they would be operating under conditions that would not provide suitable treatment for waste water.

The quality of sewage expected from a school source is a determinant to system design. If gray water is recirculated for use in flushing toilets, the result is a more concentrated sewage that requires more treatment for the removal of contaminants. Similarly, low flush fixtures will give more concentrated sewage. Waste water effluent quality is controlled by codes, both Federal and State. Minimum levels of treatment are required by these codes, but are not always possible to a village community. A clear understanding of the level of treatment required by code, and the physical ability to live up to that code, is necessary before designing any facility.

3.23 Soil Conditions:

Considerations:

Soils are a very critical determinant in use of waste water systems. Where on-site systems are required or expected to be utilized, soils which are used as backfill for absorption trenches must be of such a nature that they will not clog with extended use. Fine-grain, silty, or clayey soils are not suitable for use of on-site septic systems. Some regions of Western Alaska are gravel deficient. If gravel is needed for construction, it must be transported long distances; otherwise, alternative methods of construction must be used.

Soils information is also vital to the decision of whether or not a lagoon can be built. Pipeline construction is also dependent on soil conditions.

3.24 Disposal Conditions:

Considerations:

After waste water has received some type of treatment, it must be disposed of in some safe manner. It must either be absorbed into the soil, placed into some surface receiving water, or evaporate into the atmosphere. As mentioned in Section 3.23, above, the condition of the soil is important to its capability to absorb moisture. When a system of soil absorption is used, however, the most important consideration is separation of the soil absorption system from any existing or proposed water source. Those separations are prescribed by the Alaska Department of Environmental Conservation.

In order for treated waste water to be disposed of to any surface water of the State of Alaska, it must receive at least secondary type treatment. Secondary treatment standards are difficult to meet in bush communities. Alternative methods have to be found for most villages. Those alternatives include man made lagoons or natural ponds. In many cases, these lagoons or ponds do not have any outlet, and water is removed by evaporation.

The construction of any disposal system is affected by the environmental determinants described in Section 2.0. Pipes, pipe supports, insulation, and lagoon and drain field construction are all affected by the water table, freezing conditions, and permafrost.

Ice build-up in lagoons is a major problem in waste water treatment. The volume of water available in the lagoon for aerobic decomposition may be reduced drastically. The need for a deeper lagoon than those used in more temperate zones is apparent. Evaporation will also be held down by the existence of ice; however the possibility of loss of moisture through sublimation may not be hindered. As more lagoons are used for sewage treatment and disposal, some of these factors involving cold weather conditions will be more clearly understood. Both fresh and salt water flooding also affect construction of waste water disposal facilities throughout much of Western Alaska.

3.3 SOLID WASTE:

3.31 Existing System:

Considerations:

The principal determinant for the utility which accommodates solid waste disposal is the answer to the question of whether or not there is an existing system in the village. If a system exists, a determination should be made of the equipment available to haul refuse, and the frequency of refuse pickup.

If an existing system is not available for school use, some alternative method will be necessary. Suitable refuse storage will be needed in a convenient location at the school building. Some method of transporting the refuse to the disposal site will be necessary. If no village disposal site is available, then provisions will have to be made for disposal in an area available to the school. Incineration is a method of reducing the volume of refuse, but care must be taken to prevent the spread of fire. Air pollution is seldom a problem in a remote village; so incineration has been useful in keeping refuse from becoming an insurmountable problem. Compaction is another method of reducing refuse volume.

Environmental determinants, i.e., freezing conditions, permafrost, snowfall, and flooding, also affect solid waste disposal. Wind is always a factor in disposing of refuse, as well as storing refuse for pickup.

3.4 ELECTRICAL POWER:

3.41 Availability and Reliability of Utility Power:*

Considerations:

1. Decision to Incorporate On-site Generation:** Existence of a reliable commercial power source would virtually eliminate the need for on-site generation with its attendant costs and operating difficulties. Unfortunately, few villages in Alaska can claim such a system; as a result, some type of on-site generation is required at almost all locations.

   * Utility power means a local, commercial power generation and distribution plant.

   ** On-site generation means generation owned and operated by the school.

2. Rating of On-site Generating Units (Heavy Duty Prime Rated Versus Light Duty, Standby Rated): The rating of on-site generating units should be determined by the hours of operation expected each year. Where utility power is reasonably reliable, cheaper light-duty generating sets may suffice.

3. Capacity of On-site Generating Sets: Where utility power is expected to be out of service for long periods, on-site generation may have to be large enough to carry the entire school load. Otherwise, a small generator large enough for "essential" loads, e.g.. furnaces, etc., may be desirable.

4. Fuel Storage Capacity For On-site Generation: The amount of fuel storage dedicated to on-site generation will be influenced by the amount of generation anticipated.

3.42 Cost of Utility Power:

Considerations:

1. Decision to Incorporate On-site Generation: Even where a good utility system exists, cost of purchased power may make on-site generation attractive. Part of the cost of on-site generation may be offset by use of waste heat.

2. Consideration of Alternate Generating Sources (Wind, Water): Although usually requiring too much initial capital to be cost effective, supplemental generation by wind or water may become practical at some sites.

3.43 Utility Power Voltage Regulation:

Considerations:

1. Use of Voltage Sensitive Equipment: Small village utilities are notorious for poor voltage regulation. Motors, relays, and some forms of electronic equipment are especially vulnerable.

2. Use of Voltage Regulators: Installation of voltage regulators should be considered. Where used, bypass switching should be provided so that the voltage regulator can be taken out of the circuit without permanently removing power from the school.

3.44 Utility Power Voltage Characteristics:

Considerations:

1. Use of Three-phase Equipment: Many village systems are single phase, prohibiting the use of three-phase equipment without using single- to three-phase converters.

2. Three-phase System: Where the utility system is three-phase, the new facility should also be three-phase with loads carefully balanced to avoid voltage unbalances.

3. Distance School can be Located from Utility's Generating Plant: Many village distribution systems are low voltage (200 or 480 volts). Schools located too far from the generating plant may experience prohibitive voltage drop.

3.45 Cost of Electrical Generation (Both Utility and On-site):

Considerations:

1. Use of Electric Heating and Cooking: Heating from diesel generation is an extremely inefficient use of the fuel and will always cost more than direct use of the fuel for heating.

2. Use of High Efficiency Lighting Fixtures and Lighting Controls: Lighting requirements use a major portion of electrical energy expended in a school. Efforts to minimize lighting have a direct effect on electrical costs.

3.46 Logistics:

Considerations:

1. Choice of Lighting Fixtures with Interchangeable Lamps: Because of the difficulty of shipping and storing lamps, the number of different types of lamps should be minimized.

2. Choice of Equipment with Anchorage/Fairbanks Based Parts and Service: Replacement and service of equipment is facilitated by use of in-State distributors.

3.47 Cold Weather:

Considerations:

1. Type of Exterior Fixtures: Incandescent and high pressure sodium lamps operate satisfactorily in cold weather. Of the two, HPS lamps are much more efficient and are recommended.

2. Raceways in Exterior Walls: Raceways in exterior walls are likely to interfere with vapor barriers and should be avoided. Surface raceway is recommended.

3. Vapor Barrier Penetration: Because vapor barrier integrity is so important, vapor barrier penetrations should be avoided. Where unavoidable, the penetration should be carefully repaired.

3.48 Soils and Permafrost:

Considerations:

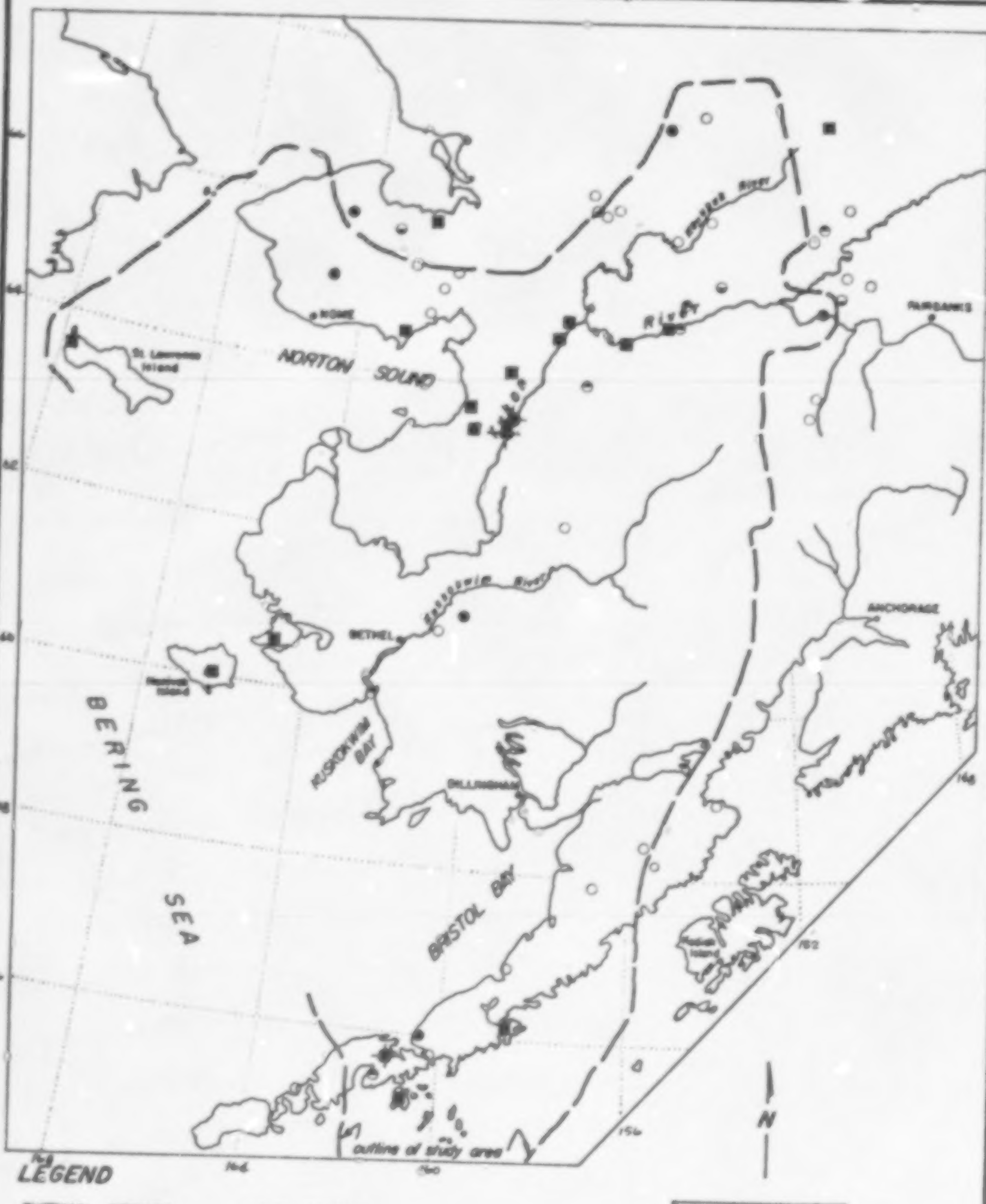
1. Type of Grounding System: Poor soils conductivity is common in most parts of Alaska where permafrost exists, and special attention to grounding systems is required.

3.49 Codes:

Considerations:

1. Electrical systems should be designed to meet the requirements of the latest edition of the National Electrical Code which has been adopted by the State or local authority. No difficulty is foreseen in meeting requirements of the N.E.C. on bush projects, with the exception of providing an adequate grounding system.

3.5 FUEL: Fuel considered for this report is defined as that providing space heating for human comfort, building systems freeze protection, and generation of electric power. Fuel referred to herein is No. 2 Arctic grade diesel fuel oil. Critical determinants of a fuel utility are not as complex as those affecting fresh water and waste water, but are equally important for providing a safe and reliable utility system. (See Figure 3.1).


NORTON SOUND
NOME
St. Lawrence Island
FAIRBANKS
Yukon River
Koyukuk River
BETHEL
Kuskokwim River
KUSKOKWIM BAY
DILLINGHAM
ANCHORAGE
Nunivak Island
BERING SEA
BRISTOL BAY
Kodiak Island
outline of study area
N
0
50
100
150 miles
146
152
156
160
166
168
64
62
60
58
56

LEGEND

THERMAL SPRINGS

● Over 150° F

● 100° - 150°

● Less than 100°

○ No data available

from map of Thermal Springs of Alaska U of A 1971

COAL SOURCES

■ Local occurrences

✦ Significant sources

from USGS paper "Mineral and Water Resources of Alaska" 1964
Jt. Fed-St LUPC SW, Yukon, NW Inventories of Minerals, Energy, and Geology 1974

THERMAL SPRINGS and COAL SOURCES

FIGURE 3.1

Considerations:

1. Existing Facilities: Existing fuel storage tanks and distribution equipment are to be utilized as a part of the total fuel system consistent with other requirements of this section. The existing fuel storage tanks and distribution equipment shall be checked for code compliance, construction, and installation, and where necessary, modified to comply with all code and using service requirements.

   If existing fuel storage tanks and equipment are properly sited and constructed, and adequate space is available, the new fuel storage facilities should be located adjacent to, and made a part of, the existing system. Siting of new fuel storage facilities should include consideration of location, clearances, accessibility, and safety.

2. Storage Requirements: Fuel oil storage facilities should provide a continuous and reliable supply of fuel oil to all equipment connected to the fuel system. Fuel storage must have adequate capacity to provide for the total fuel system consumption, plus a reasonable safety factor, for the periods between economically scheduled deliveries of fuel. The number and capacity of fuel storage tanks shall be the most economical for initial, operating, and maintenance costs.

3. Soil Conditions: Fuel storage tanks are to be located on the facility site on stable high ground, well clear of drainage areas or where flooding may occur. Storage tanks are to be provided with a firm stable foundation. Diking around tanks must be of impermeable material or provided with a liquid-tight lining.

4. Freezing Conditions: Extreme cold temperatures affect fuel oil by increasing its viscosity and resistance to flow. Therefore, consideration should be given to reducing length of fuel oil fill and distribution piping to a minimum, and oversizing where necessary to maintain flow and pumping requirements within acceptable limits.

5. Environmental Protection: Every consideration should be given to protecting the surrounding environment from fuel oil contamination. This is usually accomplished by compliance with applicable codes and EPA Regulations. Providing contaminant dikes around fuel oil storage tanks is the usual method of protection; however, all other possible sources of spill or leakage should be examined, and necessary protection provided.

6. Fuel Delivery: Methods and frequency of fuel delivery are to be considered and are very important as the most economical method will result in the lowest operating cost of the facility. Fuel storage tanks have to be sized to provide storage capacity adequate to cover the periods between scheduled deliveries. The storage tank capacity should be provided with a safety factor to cover any contingency that may occur in the scheduled deliveries. Unloading facilities are to be provided to accommodate the method of delivery.

7. Fuel Distribution to Buildings: Fuel oil distribution piping shall be located and installed in such a manner to be accessible at all times, yet provided with maximum protection from mechanical injury. Routing of fuel distribution piping is to be the most direct, consistent with physical and topographic features, to reduce pumping requirements to a minimum. If possible, the building fuel storage tanks should be located higher than the facility to provide for gravity flow. A building fuel oil storage tank is often referred to as a "day tank" when located within the building. The size is generally of a volume to hold a minimum of 24-hours supply and is filled daily. Interior location of the tank preheats the fuel for combustion. The code controls the maximum capacity allowed within the building. The fuel oil distribution system should provide the maximum reliability consistent with economical installation costs.

8. Fire Protection Codes: Installation of fuel storage and distribution systems shall comply with the applicable provisions and requirements of the National Fire Protection Association (Flammable and Combustible Liquids Code, NFPA No. 30; Standard for the Installation of Oil Burning Equipment, NFPA No. 31); Occupational Safety and Health Act (OSHA); and Environmental Protection Agency Rules and Regulations.

9. Power Requirements: Fuel storage and distribution equipment requiring electrical power for operation shall preferably be supplied with electrical power of the required electrical characteristics from the facility the fuel system serves. If, for any reason, electrical service from the served facility is difficult to utilize, then any reliable electrical source within the immediate vicinity may be used.

End of Section

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SECTION 4.0 BUILDING PROGRAM

INTRODUCTION:

The Rural Schools Prototype Analysis is primarily directed toward the design of small bush secondary schools. This section covers four separate size facilities corresponding to enrollment groups as defined in the Department of Education (DOE) guidelines. Local school districts will determine student enrollment group size based on present and anticipated future enrollment, and other appropriate criteria.

The four enrollment groups addressed are:

4.1 10 or Fewer Students
4.2 11-20 Students
4.3 21-32 Students
4.4 33-46 Students

A design programming package has been compiled which covers the following information for each enrollment group:

GENERAL CONSIDERATIONS: A brief description of the academic program, staffing, size of facility, and general operation of the school is given which is related to the intended student load. The program options that are defined in SPACE REQUIREMENTS have been combined, in diagrammatic form, to demonstrate several basic concepts of how individual program areas might be organized into a total building plan.

EDUCATIONAL PROGRAM: General program requirements are listed, e.g., math, science, physical education, etc., for each program requirement. A description of activities is given which details the types of experiences and learning group sizes that must be designed for. This, in turn, is translated into qualitative requirements for a type of building space (academic, lab, multipurpose, etc.). For instance, you would need an academic area for teaching math, and a lab area for teaching science.

SPACE REQUIREMENTS: The EDUCATIONAL PROGRAM defines the types of spaces required to accommodate particular programs. In this section, a sample building program has been developed for each space of an educational facility which outlines physical characteristics, service requirements, lists equipment and special requirements by subject area, and presents a conceptual layout or design option that represents size, character, and program limitations. This section also includes a design program for vital supplemental spaces, e.g., mechanical room, maintenance room, and toilets.

DOE SECONDARY SCHOOL SPACE GUIDELINES: The DOE Secondary School Space Guidelines summary is included at the end of each section. This summary gives the total allocation of space per enrollment group, and recommends space allocations by program area and efficiency ratios.

The BUILDING PROGRAM section is intended to be used as a programming and design guide. It may be used by school districts and architects as an initial basis for discussion on basic concepts and assignment of priorities in space allocation. In most cases, the total area required to adequately house all of the programmed areas will exceed the total allowed by DOE guidelines; the space overruns are caused by the need for more supplementary space to adequately provide for maintenance rooms, mechanical rooms that are accessible and functional, a food service area, adequately sized toilet/locker rooms, wall thickness, and general storage. In addition to basic space allocation, the specific utility and logistics may require allocation of space, e.g., sewage treatment, water treatment, power generation, etc. To keep an educational facility in operation in the bush, proper allocation of space for site and building utilities, and operation and maintenance, is of the highest priority.

While this study has been primarily directed at secondary schools and utilizes the DOE Secondary School Space Guidelines for space allocation, in reality most of the new educational facilities will be utilized as combined facilities with certain program areas being shared with an existing elementary school. Potential areas of shared use include: multipurpose, resource (library), food service, administration, and site utilities. It might be noted that the DOE guidelines for combined elementary and secondary schools is far more generous in allocating multipurpose space. In villages where BIA operates the elementary school, combined use of the secondary multipurpose room and other program areas will occur, but the schools will be operated as two separate facilities.

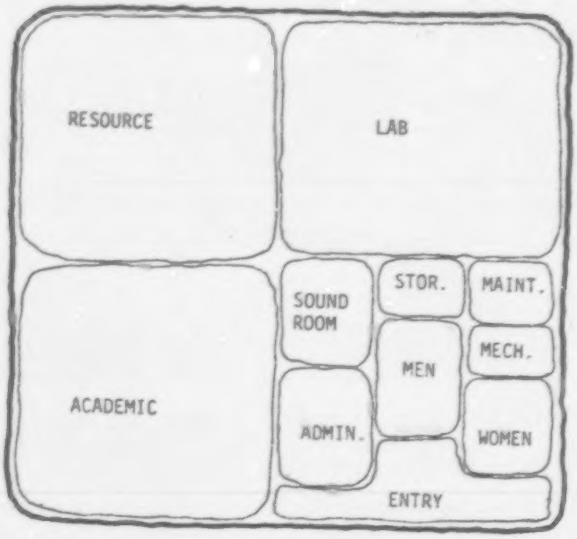
The secondary school for 10 or fewer students will be a total facility of approximately 1,100 square feet, of which 800 square feet will be designed for various high school programs and approximately 300 square feet will be needed for supplementary space, e.g., toilets, maintenance room, mechanical room, and general storage.

A school of this size will most likely be limited to one teacher who will not only teach all subject areas for a four year high school curriculum, but who must also function as the principal and assume responsibility for total operation of the school program and facility.

Space requirements as defined for the range of program offerings will influence the design, which is to be 800 square feet of open-plan broken into at least three defined areas, allowing students to work concurrently in different subject areas. The educational program will be geared to the needs of the individual student, and the teacher will need to function not only as a resource, but, due to the range of subject matter, he/she will also be a learner in many situations. Correspondence courses can be utilized to supplement program offerings.

To maximize the potential use of this facility, careful planning and coordination will be required to design multiple use areas that have adequate facilities and storage for all programs desired.

The following bubble diagram illustrates the type and relationship of spaces for a school of 10 or fewer students.



Section 4.1 / Pages 1 & 2 blank.

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Science	Students dissecting various animals and plants, performing chemical experiments; mixing fuming chemicals; sorting, categorizing and storing various rocks, plants, animals, and sea life, and putting them in display cases; viewing films/filmstrips.	Lab (Project Area)
Math	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 1-4: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Language Arts	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips.	Academic Area

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Language Arts (Con't.)	Discussion: Groups of 1-4: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area (Con't.)
Social Studies	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 1-4: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Physical Education	Practicing skills and participating in fitness and related outdoor physical activities (e.g., basketball, calisthenics, track and field, cross-country skiing, softball, flag football, soccer, snowshoeing, dancing).	No Interior Space

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Electives:		
Home Science	Small groups of students working in the four skill areas of cooking, sewing, homemaking, and child care, as well as passively reviewing TV and films as a group, and slide and/or filmstrips; cassette tape presentations as a group or as individuals. Cooking: Frying, baking, mixing, washing dishes, measuring, cooking, freezing. Sewing: Measuring, laying out, sewing, cutting, pressing or ironing, etc. Homemaking: Interior design, entertainment, food storage, family living, cleaning, washing and drying clothes, home nursing. Child Care: Dressing, feeding, holding, entertaining, observing.	Lab (Project Area)
Business Education	Typing: Students will in general be working individually or in groups of 1-2. Students will learn individually, studying in carrels using slide-tape machine and typewriters.	Sound Module or Lab

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Business Education (Con't.)	Office Practice: Students will learn and work individually with various office machines.	Sound Module or Lab (Con't.)
Music	1) Performing: (a) Singing (b) Playing instruments, optional w/sound module 2) Listening 3) Creating	Academic Area
Art	1) Painting 2) Drawing 3) Pottery making 4) Carving 5) Printmaking 6) Constructing 7) Forming 8) Weaving 9) Etching.	Lab (Project Area)
Trade & Industries	Assembling, disassembling small engines; measuring, sawing, fitting, gluing, nailing, sanding, building, blueprint reading, drafting.	Lab
Library/Media	The focus of the academic area is envisioned to be the learning resource center. It will be a depository for educational resources and an area for individual study. It should be readily accessible to individuals and groups and should be closely related to specialized learning laboratories.	Resource Area w/Carrels

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Library/Media (Con't.)	One of the major components in the learning resource center which can bridge both learning and social differences from remote areas to the outside world is the audio-visual information center. Here, a well supplied source of learning materials can bring the world of today into the classroom for all students.	Resource Area (Con't)
Auxiliary Services:		
Administration	Counseling students individually or in small groups; greeting and/or talking to parents and other groups; filing reports and permanent records; typing reports, conducting phone and radio communications, duplicating of teaching material, and testing.	Teacher Office Area
Food Service	Extent of activity to be determined by school district.	Lab/Storage

1. ACADEMIC AREA

The academic area should provide for conventional educational experiences but should be flexible enough to accommodate changes in enrollment, learning-group sizes, activity requirements, and teaching methods. The academic area should provide for instruction in the following program areas: math, social studies, language arts, music, and other electives.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Material: (Quality)

1. Walls: High light reflectance.
2. Floors: Acoustic; color should resist effects of soiling.
3. Ceiling: Acoustic.

Windows: Windows are desirable to provide psychological relief, back-up ventilation, and emergency exits, but their use must be limited to minimize heat loss and potential distraction.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at desks and chalkboard.
2. Power: Two outlets or power poles on each wall.
3. TV jack.
4. Clock (battery).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Math:

Item No.	Equipment List
a.	Chalk and tackboards
b.	Student seating (1-10); desks or tables
c.	Overhead projector
d.	Tape recorder with headsets
e.	Math lab supplies kit
f.	Calculators (hand)
g.	Projection screen (wall or ceiling mounted)

Special Requirements:

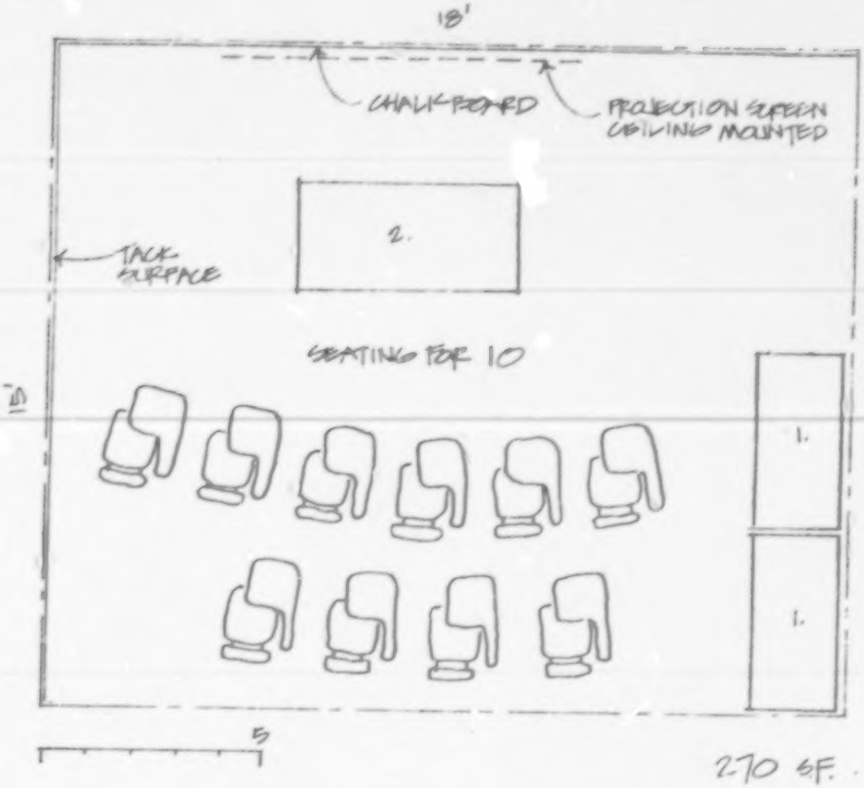
1. Power strip.
2. Project storage space (tote trays).
3. TV jack.

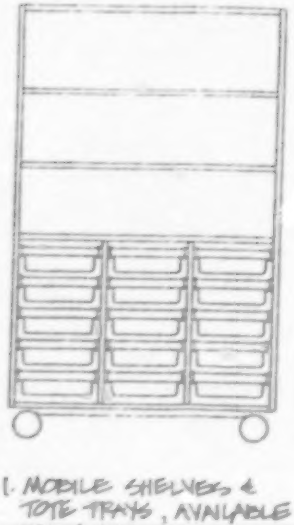
Language Arts:

Item No.	Equipment List
a.	Same as Math (not including calculators)

Social Studies:

Item No.	Equipment List
a.	Same as Math and Language Arts


18'
CHALKBOARD
PROJECTION SCREEN
CEILING MOUNTED
TACK SURFACE
2.
SEATING FOR 10
15'
1.
1.
5
270 SF.



1. MOBILE SHELVES & TOTE TRAYS, AVAILABLE WITH DOORS

2. DESK OR TABLE

2. LAB (PROJECT AREA)

The lab (project area) for the 10 or fewer enrollment group should be designed to accommodate science, home science, and art programs. This area might also be used in connection with business education, shop, and a food service program. However, if a food service program is to be included as a part of a multiuse lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. This facility should allow for ease in adaptation from one program to another. Careful planning for storage of all equipment and student projects for each activity, along with the specification of multiuse counter areas, will be necessary to achieve a functional design.

In this facility, the home science and food service program will be required to use disposable dishes and utensils due to Environmental Health sanitizing requirements.

In the 10 or fewer enrollment group, there is no allotment of space for a shop. The Trades and Industries (T & I) program will be limited to the use of a Ken Cook Trans-national Learning Station. Additional T & I programs may be instructed in the general classroom area, or outside in fair weather.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: (Quality). One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable (e.g., V.A.T.).
3. Ceiling: Washable finish.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at counter and table tops.
2. Power:
   a. Plugstrip around walls above countertop.
   b. 120/208-V., 3-phase.
   c. TV jack.

Mechanical:

1. Ventilation: Noxious fume exhaust; rangehood exhaust.
2. Plumbing:
   - a. Hot and cold water.
   - b. Acid-resistant waste pipes (Science).
   - c. Plaster trap in sink (Art).
   - d. Gas for Bunsen burner desired (Science).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Science:

Item No.	Equipment List
a.	Mobile student science cart
b.	Science table w/acid-resistant top and 4 stools
c.	Microscope (2)
d.	Plant study kit
e.	Electricity kit
f.	Simple machines kit
g.	Weather station
h.	Aquarium, 10 gallon
i.	Terrarium, 10 gallon
j.	Scale and spring balance, 15 kg. capacity
k.	Rock and mineral collection
l.	Dissecting set (advanced type for 4)
m.	Hot plate - 660 W., single unit
n.	Ammeter
o.	Pump (hand-air vacuum and pressure)
p.	Basic set of chemicals (provide locked storage)
q.	Assorted test tubes and flasks
r.	Assortment of science charts
s.	Project storage

Special Requirements:

1. Storage cabinet with locking doors.
2. Sink (chemical and abrasion resistant).
3. Noxious fume exhaust.
4. Bunsen burner hook-up (desired).
5. Built-in display cases (desired).
6. Electrical outlets: minimum of 4, plugstrip desired.
7. Chalk and tackboard.
8. Storage for flammable materials.

Home Science:

Item No.	Equipment List
a.	Kitchen range, 2-4 burner stove
b.	Double sink
c.	Base cabinets with counter
d.	Overhead storage cabinets
e.	Assortment of small appliances (storage space to be provided)
f.	Portable sewing machine (2)
g.	Table with 4 chairs
h.	Fitting mirror
i.	Ironing board and storage (1)
j.	Tote drawer cabinet
k.	First aid kit
l.	Washer/dryer (optional)
m.	Assorted dishes, pots and pans
n.	Refrigerator/freezer
o.	Microwave oven (optional)
p.	File cabinets
q.	Food and staples storage

Special Requirements:

1. Plugstrips.
2. 140 degree hot water (desirable).
3. Chalk and tackboards.
4. TV jack.

Art:

Item No.	Equipment List
a.	Table with 4 chairs
b.	Drawing boards (4)
c.	Easel (1)
d.	Assortment of supplies
e.	Project storage
f.	Double sink with plaster trap
g.	Display space
h.	Chalk and tackboards

Food Service:

Item No.	Equipment List
a.	Stove
b.	Microwave oven (optional)
c.	Refrigerator/freezer
d.	Food, utensil, and paper storage
e.	Sink

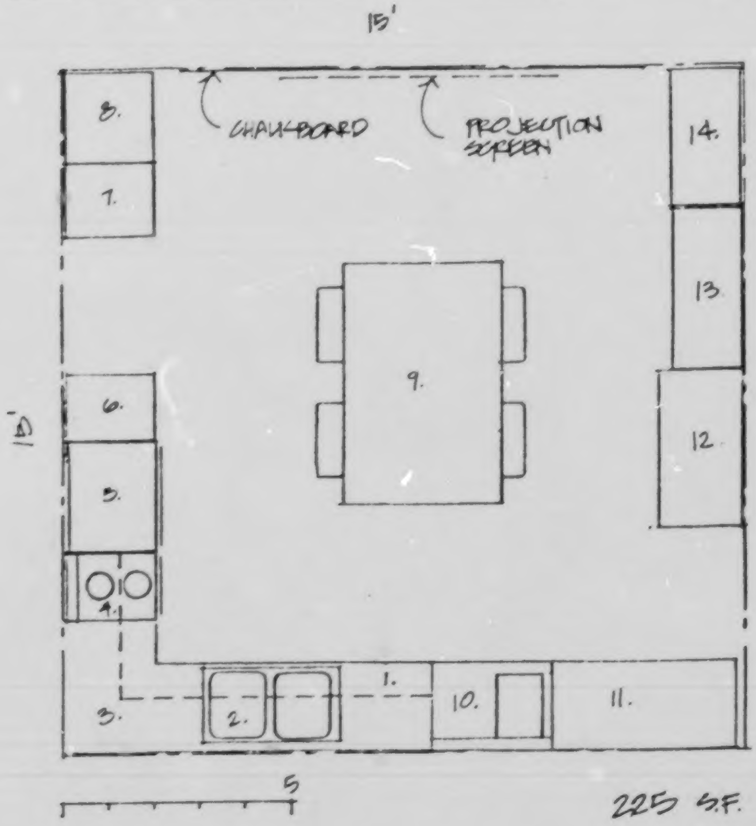
Trades and Industries:

Item No.	Equipment List
a.	Ken Cook Trans-national Learning Station, including equipment

Special Requirements:

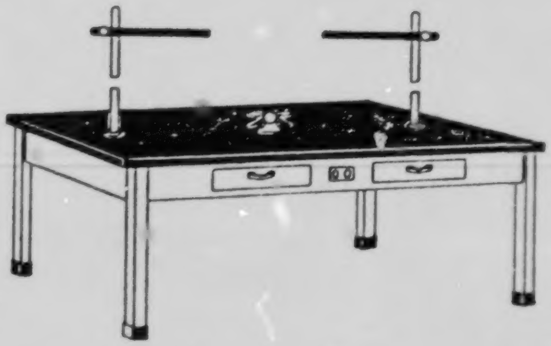
1. Power plugs or poles.
2. Task lighting.

CONCEPTUAL LAYOUT LAB (PROJECT AREA)


15'
8.
7.
CHALKBOARD
PROJECTION SCREEN
14.
13.
9.
15'
6.
5.
4.
12.
1.
3.
2.
10.
11.
5
225 S.F.

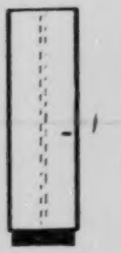
HOME SCIENCE

1. BASE CABINETS W/COUNTER
2. STAINLESS STEEL SINK
3. WALL HUNG CABINETS
4. 2 BURNER RANGE
5. REFRIGERATOR/FREEZER

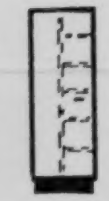


9. FOUR STUDENT TABLE

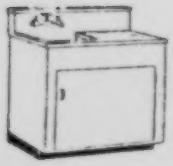
6. FOOD & STAPLES



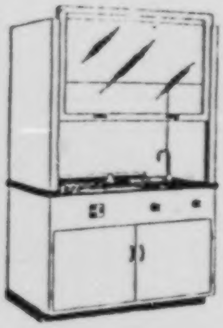
7. TOTE TRAYS (28)



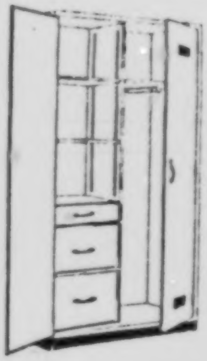
8. IRONING BOARD STORAGE



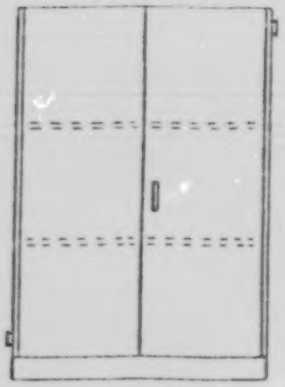
10. LABORATORY WALL SINK



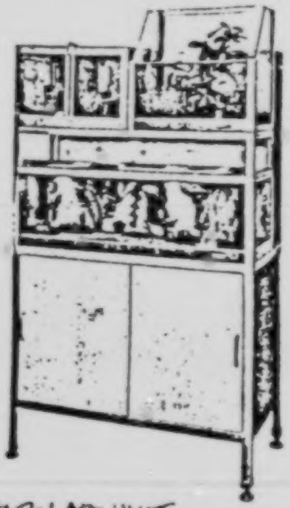
11. FUME HOOD



12. WARDROBE AND SUPPLY CASE



13. FLAMABLE STORAGE



14. BIO-LAB UNIT

3. RESOURCE AREA

The resource area is the focal point of the educational environment in the small high school. This area will be used primarily for individualized study, but may also be used for instruction and to provide for an informal seating and meeting area. This area will be the primary depository and distribution point for educational materials and equipment, e.g., books, tapes, films, projectors, recorders, etc.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials:

1. Walls: High light reflectance; acoustic.
2. Ceiling: Acoustic.
3. Floors: Acoustic; color selection to minimize effects of soiling.

SERVICE REQUIREMENTS

Electrical:

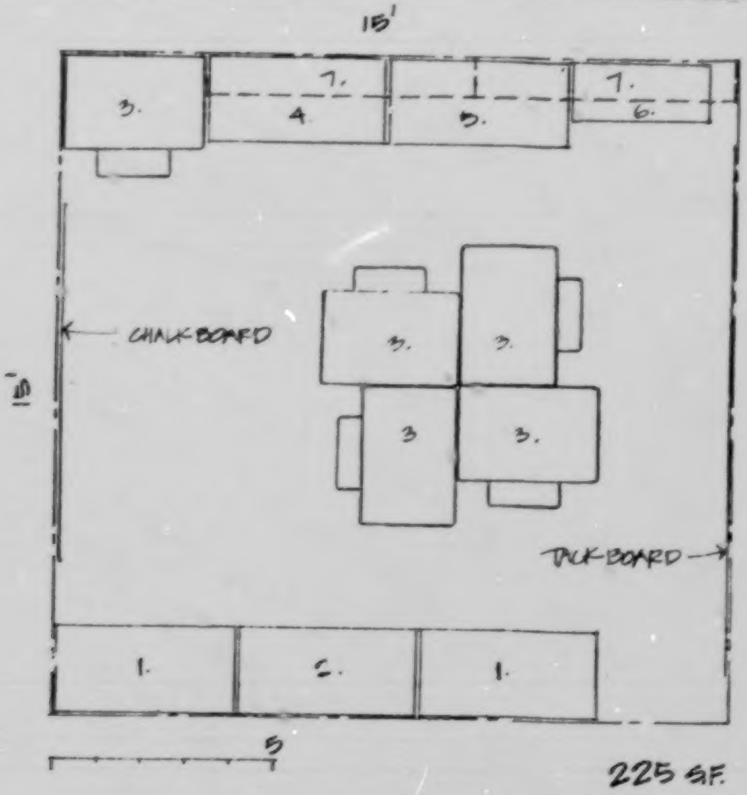
1. Lighting: Variable; 70 FC on desks in reading/study area.
2. Power: Plugstrip around walls and power poles in center to provide power for carrels.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

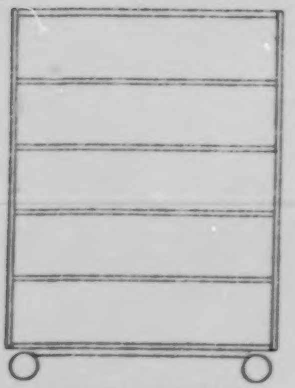
Library/Media:

a. Carrels (5)
b. Books and periodical storage
c. A/V equipment storage:
  - 16 mm. projector
  - 35 mm. slide/filmstrip projector
  - Overhead projector
  - Microfilm viewer
  - Video-tape recorder/player
  - TV camera
  - Cassette and video-tape storage
d. TV jack

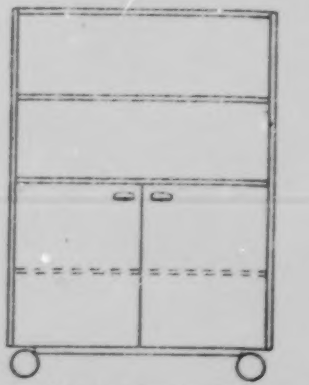
CONCEPTUAL LAYOUT RESOURCE AREA


15'
3.
7.
4
5.
7.
6.
CHALKBOARD
15'
3.
3.
3
3.
TACKBOARD
1.
2.
1.
5

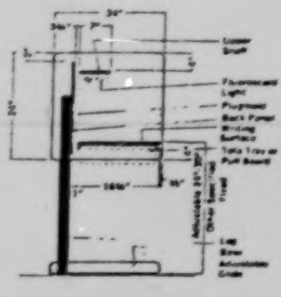
225 S.F.



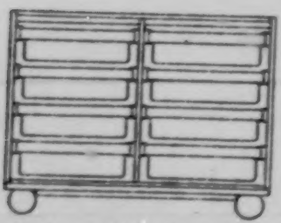
1. MOBILE BOOKSHELF



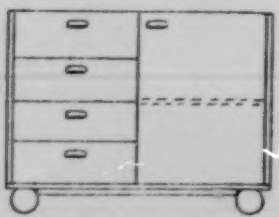
2. MOBILE BOOKSHELF & CABINET


Upper Shelf
Fluorescent Light
Pegboard
Back Panel
Writing Surface
Tote Tray or Pull Board
Leg Brace
Adjustable Glide

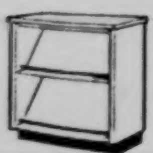
3. STUDY CARREL



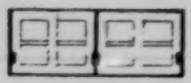
4. MOBILE TOTE TRAYS



5. MOBILE DRAWERS & CABINET



6. MAGAZINE SHELVING



7. WALL CABINET

4. SOUND MODULE

An expandable, movable sound module might be provided for use in coordination with business and music programs, and may also serve as a private area for study or small meetings. The use of an independent module would provide an excellent space for acoustically isolating certain activities.

PHYSICAL CHARACTERISTICS

1. As specified.

SERVICE REQUIREMENTS

Electrical:

1. Power: Hook-up.

Mechanical:

1. Hook-up as specified.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

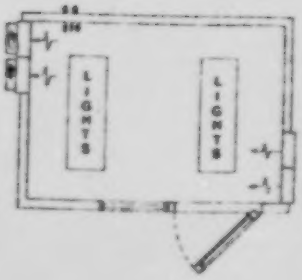
Business Education:

Item No.	Equipment List
a.	Typewriter and stand
b.	Office machines, e.g., adding machine, printing electric calculator, duplicating machine
c.	Chalk and tackboards
d.	Supplies and storage

Special Requirements:

1. Acoustic treatment.

CONCEPTUAL LAYOUT SOUND MODULE


LIGHTS
LIGHTS

5. TEACHER OFFICE AREA/ADMINISTRATION

The teacher in the small school is a person of many responsibilities and functions. The teacher office area for the 10 or fewer enrollment group must function as a multipurpose space. Besides serving as a teacher's station that is accessible to students and allows for maximum area observation, this space must serve the teacher as an administrative office area. Secure storage for student records and funds, and space for the school radio or CB, must be provided.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: (Quality)

1. Walls: Acoustic.
2. Ceiling: Acoustic.
3. Floor: Acoustic.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC on desks.
2. Power:
   a. Miscellaneous outlets.
   b. Radio, TV antennae.
   c. Telephone jack.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

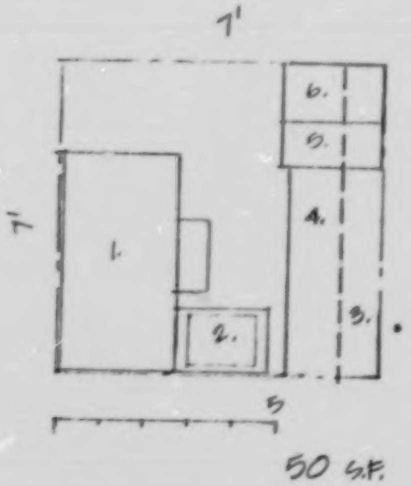
Administration:

Item No.	Equipment List
a.	Desk and chair
b.	4-drawer file cabinet with lock
c.	Bookshelves
d.	Small conference table (optional)
e.	Secure storage for student records and money
f.	Telephone/radio/CB
g.	Typewriter and stand

Special Requirements:

1. Power strip.
2. Task lighting.

CONCEPTUAL LAYOUT TEACHER OFFICE AREA



1. DESK
2. TYPEWRITER STAND
3. BOOKSHELF
4. BASE CABINETS WITH COUNTER-TOP
5. 4 DRAWER LETTER FILE
6. 4 DRAWER LEGAL FILE

6. OUTDOOR RECREATION AREA

In the 10 or fewer enrollment group where no interior space for physical education is allocated, it is desirable to provide a defined exterior area, e.g., wood deck, for structured activities such as basketball, volleyball, etc. It may be desirable to locate the deck adjacent to a blank wall of a building so that the building might serve as a backstop or be used for mounting a basketball backboard. In locating a recreational area, environmental considerations, e.g., orientation to sun and wind, should be primary determinants.

SERVICE REQUIREMENTS

Electrical:

1. Exterior lighting.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Basketball standard(s)
b.	Volleyball standard(s)

SUPPLEMENTARY SPACE

7. TOILETS

The level of feasible service will be determined on a site-specific basis. Actual fixture counts will vary due to code interpretations, enrollment, utilization of facility, village population, and availability of water. In determining the number of fixtures required, consider the possibility of increased enrollment and community use. The following facility recommendations are for the 10 or fewer student enrollment group:

	Men	Women
Water Closets	1	1
Urinals		
Lavatories	1*	1*
Showers		
Drinking Fountain	1	

* Can share lavatory.

PHYSICAL CHARACTERISTICS

Ceiling Height: 7.5 feet minimum.

Materials: (Quality)

1. Walls: Water resistant; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Water and wear resistant.

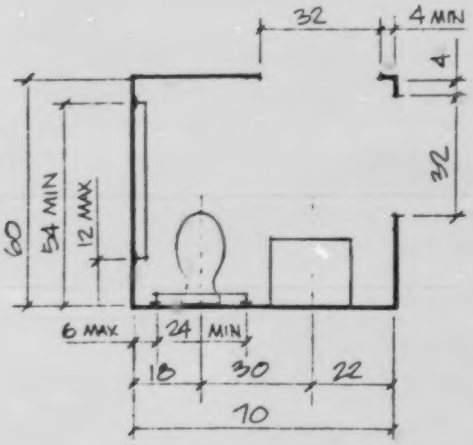
SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC; vapor-tight and vandalproof fixtures.
2. Power: Outlets ground fault protected.

Mechanical:

1. Heating: 70-75 degrees F.
2. Plumbing (site-specific):
    a. Water - tempered.
3. Exhaust air.


4 MIN
54 MIN
12 MAX
6 MAX
24 MIN

SUPPLEMENTARY SPACE — 8. MECHANICAL/ELECTRICAL AREAS

The mechanical room and electrical panel should be located on the main level and be easily accessible and close to an entry (not on an upper level or in an attic space).

The pending freeze-up danger and the unavailability of a local repair service with a spare parts inventory, increase the need for a well-planned mechanical/electrical room. It is very important to provide enough room in this space to easily service all equipment. Too often in the early stages of design, this area is established by the architect without adequate consultation with the mechanical and electrical engineers. The failure of one of these systems, and an inability to have ready access for diagnosis and repair, can result in serious damage to the facility and its contents and loss of a school program. However, the room should be planned to not have more space than is needed for equipment servicing (including major replacement); too much space will result in unauthorized storage of materials in this room (a code violation). Doors, knock-out panels, or some means of egress for the largest piece of equipment must be provided for future replacement. The electrical and control panels should be located so that the net clear space (minimum 30 inches by code) in front of them must be used for circulation space within the mechanical room. This helps to prevent the storage of materials in front of the panels (panels may be located elsewhere in the building with these guidelines applied).

PHYSICAL CHARACTERISTICS

Size: 6'-0" x 8'-6" bare minimum (will vary with equipment used).

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 808.

1. Walls: High light reflectance; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Combustible or noncombustible surface depending on fuel-fired equipment specified; noncombustible recommended to reduce fire hazard of absorbed fuel oil.

SERVICE REQUIREMENTS

Electrical:

1. Lighting. 20 FC.
2. Power: Two outlets; ground fault protected (minimum).

Mechanical:

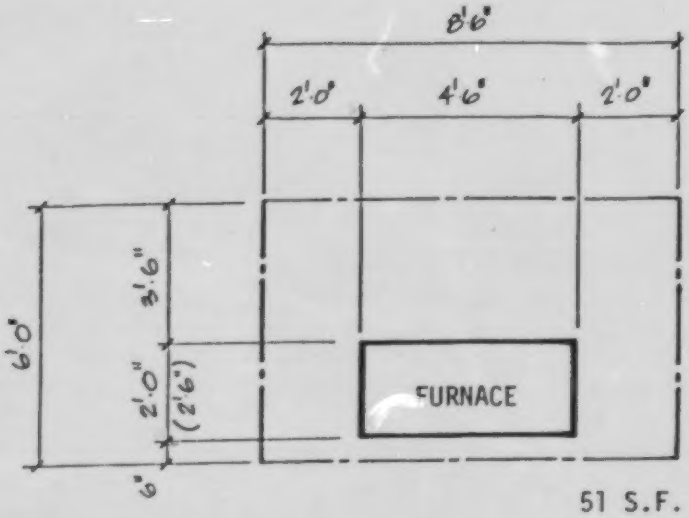
1. Fuel supply and day tank.
2. Furnace.
3. Hot water heater.
4. Space for offset chimney.

CONCEPTUAL LAYOUT — MECHANICAL/ELECTRICAL AREAS

Building Size: 1,100 S.F.

Note:

1. Heating load assumed to be 60,000 BTU/HR.
2. A simple "pot-type" oil-burning stove should be installed, centrally located to heat entire building under emergency conditions.
3. Hot Water Heater: Electric, 2 KW.



51 S.F.

(1) Furnace (No Standby):

BTU Each Furnace:	95,000
Furnace Dimensions:	24" x 54"
Furnace Room Dimensions:	6'-0 x 8'-6'

SUPPLEMENTARY SPACE

9. MAINTENANCE ROOM

The maintenance room is provided within the small rural high school as a space for building repair, daily cleaning, and storage. It is required by building code that this space not be part of the fuel-fired equipment room. Workbench and storage shelving should be carefully planned and built-in to prevent this space from being used for unauthorized purposes. This room must be large enough to house all cleaning equipment (vacuum, mops, ladder, cart, brooms, etc.), a minimum quantity of cleaning supplies and products, a mop sink, a workbench (30" x 60"), and storage for tools, manuals, maintenance records, and spare parts. This space must be well lighted, accessible, and adequately sized to meet the needs of the local maintenance program requirements. Usually the maintenance room will be located on a plumbing wall adjacent to the toilet areas to minimize plumbing runs.

PHYSICAL CHARACTERISTICS

Size: 76 square feet minimum.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Construction; see UBC, Section 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: General 30 FC, and 70 FC for task lighting over workbench.
2. Power: Three outlets; ground fault protected (one at workbench height).

Mechanical:

1. Plumbing: (Site-specific).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Maintenance:

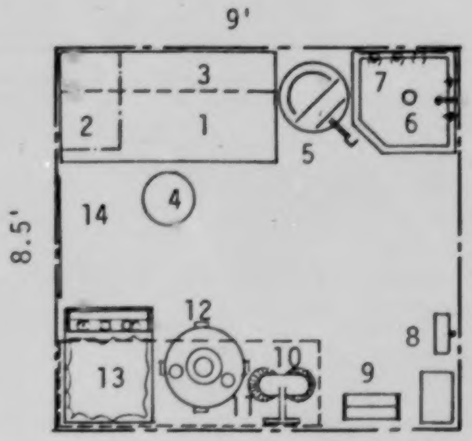
Item No.	Equipment List
a.	Mop sink
b.	Mop rack
c.	Shelving (above and below workbench)
d.	Vacuum cleaner, hose, and attachments
e.	Janitorial cart (optional)
f.	Ladder
g.	Miscellaneous cleaning supplies (gallon containers)
h.	Miscellaneous paper products (2 week's supply)
i.	Building maintenance tools
j.	Large push broom
k.	Large push dustmop
l.	Snow shovel, ice chipping tool
m.	Wet mops
n.	Mop bucket with wheels and wringer
o.	Vise
p.	Tool box
q.	1-drawer file cabinet

Special Requirements:

1. Workbench with metal surface.

CONCEPTUAL LAYOUT MAINTENANCE ROOM

1. WORK BENCH W/METAL SURFACE
2. 2 DRAWER FILE CABINET
3. TOOL & PARTS STORAGE
4. STOOL
5. MOP BUCKET
6. MOP SINK
7. MOP & BROOM RACKS
8. SHOVEL & MISCELLANEOUS BUILDING MAINTENNANCE TOOLS
9. STEP LADDER
10. FLOOR CLEANER
11. PAPER & CLEANING SUPPLY STORAGE
12. VACUUM CLEANER
13. JANITORIAL CART
14. PORTABLE SCAFFOLD



76 SF

SUPPLEMENTARY SPACE

10. CIRCULATION

The defined circulation space in the facility for 10 or fewer students will most likely be limited to space devoted to the entry area as shown in the conceptual bubble diagram. In an open-plan concept, actual circulation space exists, but is not specifically labeled as such on the plan. Circulation paths in these small facilities should avoid dissecting a program area, and should instead be used to emphasize teaching stations and minimize disruptions.

The design of circulation space as an exit corridor will need to comply with the State Fire Marshal's current code interpretations if an alcove off this space is to be used for storage of students' coats and books. 1/ Handicap maneuverability, clearance, and surface finish requirements should be taken into consideration when designing circulation paths.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum recommended.

Materials: (Quality). Exit Corridors - see UBC, Section 3304(g).

1. Walls: Durable; readily cleanable; moderate light reflectance.
2. Floors: Acoustic; color should mask effects of soiling. (At Entries: absorptive and/or readily cleanable and water resistant surfaces).
3. Ceiling: Durable acoustic.

Windows: Desirable to provide psychological relief.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: Variable 20-30 FC, general area. Increased lighting in display and planting areas.
2. Power: Miscellaneous outlets per owner's request.

Mechanical:

1. Heating: 70 degrees F.
2. Drinking Fountain: Where applicable (per handicap code requirements).

1/ Taken from Minutes of Meeting on 6/30/78 with State Fire Marshal. Subject to reinterpretation by State Fire Marshal's office; reader to confirm details.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Student coat and book storage
b.	Display cabinets (optional)
c.	Seating (optional)
d.	Tack surfaces

SUPPLEMENTARY SPACE

11. GENERAL STORAGE

Adequate storage specifications will be site-specific. Each particular school district must develop specifications according to its purchasing-stocking-shipping requirements and the specific logistics of each site. One option for cold storage is to provide a more cheaply constructed, separate, unheated storage building on the school site. Often, existing structures can be cheaply modified for storage use. A creative custodian and school staff can maximize storage space if unneeded items are disposed of and material inventories are carefully monitored (one small school was found annually ordering envelopes without realizing they had an 80 year supply). Suggestions that help assure that the storage room is used as programmed include shelving installed at construction, a minimum of circulation space, minimum electrical outlets, and utilization of odd shaped "left-over" areas. Long-term storage can be provided in attics and mezzanines when provided with access that is convenient and heavy enough for carrying the supplies to the space; however, all storage rooms must be One-hour Fire-resistive Construction. If the storage room is located on the second level, the State Fire Marshal is currently classifying the facility as a 2-story structure due to the potential of the storage room being used as a classroom. (See Section 5.40).

Three separate storage areas are needed for each school to provide for:

1. Plant Support Materials: Toilet paper, extra pipe, spare parts, cleaning supplies, oil, etc.
2. General Instructional Supplies: Books, paper, audio-visual equipment, etc.
3. Food Storage: (Food must be stored on shelves or pallets above the floor, and food must not be stored in classrooms or the boiler room).

PHYSICAL CHARACTERISTICS

Size: (site-specific).

1. Plant Support Materials: 80 square feet (8' x 10').
2. General Instructional Supplies: 80 square feet (8' x 10').
3. Food Storage: 84 square feet (6' x 14'); Class "A" lunch program.

Ceiling Height: Varies (if less than 6'-6", this can be considered "bonus" space according to DOT/PF Design Standards for Space Utilization).

Materials: One-hour Fire-resistive Construction Per UBC 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Varies (use minimum required).

Mechanical:

1. Heated or Unheated: Varies (site-specific).
    a. Plant Support Materials: Above 32 degrees F.
    b. Food Storage: Cold - 0 degrees F.; Dry Goods - 60 degrees F. or below.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Industrial grade adjustable shelving w/12" wide shelves.

SUPPLEMENTARY SPACE

12. FOOD SERVICE

The food service program for a secondary school of 10 or fewer students will depend on several factors:

1. Local village priority for food service program versus other programs.
2. Ability of secondary school to share use of food service program at elementary school, or in the other instance, the need to provide for a combined food service program as a part of the secondary school.
3. Type and extent of food service program being offered by the school district.

The food service program is a major operational expenditure. To reduce operating costs, some districts are switching their program from the traditional hot lunch to a program where frozen dinners are heated in convection ovens and served to the students with disposable dishes and utensils. This not only cuts down on the cost per meal, but also reduces the need for an elaborate kitchen, minimizes staffing, and allows more space and budget to be devoted to operating the educational program. In some villages, this frozen dinner program may not be popular if it causes a reduction in local employment.

The frozen dinner program does not need a separate kitchen and may use home science equipment provided in the lab area. However, if the food service program is to be included as a part of the lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. If proper sanitizing for dishwashing is unavailable, disposable dishes and utensils must be used for the food service program as well as for home science. If the lab is utilized for this type of food service program, additional space must be provided for the storage of dry goods, frozen goods, and paper products, depending on frequency of delivery. It may also be desirable to specify a commercial convection oven.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable.
3. Ceiling: Washable.
4. Base: Coved, washable.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC general area; 70 FC task lighting; vapor-tight fixtures.
2. Power: 120/208-V, 3-phase; load varies with equipment.

Mechanical:

1. Heating: 65 degrees F.
2. Ventilation: Use range hood; draw make-up air from adjacent areas.
3. Plumbing:
   a. Waste: Sink requires grease trap which presents problems with or without this unit.
   b. Water: Hot and cold. Sanitizing water (140 degrees F.) required if washing dishes or utensils.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Frozen Dinner Program:

Item No.	Equipment List
a.	Convection oven
b.	Sink
c.	Disposable dishes and utensil storage
d.	Dry goods storage
e.	Frozen goods storage
f.	Refrigerator
g.	Exhaust hood

SUPPLEMENTARY SPACE

13. ON-SITE GENERATION

Some level of on-site electrical generation will be required at nearly every site. Size, type, and number of generating units will vary according to the size of the school and availability, reliability, and cost of commercial power (see discussion in Section 9.42, Building Utilities). Levels of on-site generation will be divided into three general categories:

> Level One; Minimum Standby: On-site generation of minimum capacity required to keep essential systems operating to prevent damage to the school during commercial power outages. Unit is sized to power a few lights and building heating equipment. Use of the school would not be possible while on standby power. This level of on-site generation would be applicable to those sites having reasonably reliable commercial power systems where power outages would be expected to occur infrequently and be of short duration.
>
> Level Two; Full Standby: On-site generation with sufficient capacity to allow normal operation of the school during loss of commercial power. Standby generation would be provided by a single unit sized to accommodate the full load requirement of the school. This level of on-site generation would apply where outages of several days' duration can be expected.
>
> Level Three; 100% On-Site Generation: On-site generation to provide 100 percent of the school's electrical energy would consist of two generating units sized to accommodate the school's full load requirements, plus one smaller generating unit for night and weekend loads. This level of on-site generation would apply where commercial power is unavailable, too unreliable, or too costly to be used.

Space requirements for any level of on-site generation must allow easy access to both sides and rear (generator end) of each generating unit for maintenance and repair. Space must also be provided for proper clearance in front of switchgear, and for working clearance around any auxiliary equipment. For Level Three generation, workbench space should be provided, in addition to the workbench space provided in the school maintenance room.

Space for Level One generation might be provided within the school building itself. As an alternative, Level One generation could be provided by a portable, air-cooled, fully enclosed unit which is moved from storage into place outside the school and plugged into an exterior connection when needed.

Level Two and Three generation should be installed in a building separated from the school and all other buildings by at least 20 feet for fire and noise reasons.

PHYSICAL CHARACTERISTICS

Size: Varies with level of on-site generation and physical size of generating units:

Level One: 90 square feet.
Level Two: 120 square feet.
Level Three: 264 square feet.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Table 5-B.

1. Walls: Taped gypsum board.
2. Ceiling: Taped gypsum board.
3. Floor: Non-absorptive; nonslip (metal with abrasive finish; light weight concrete).

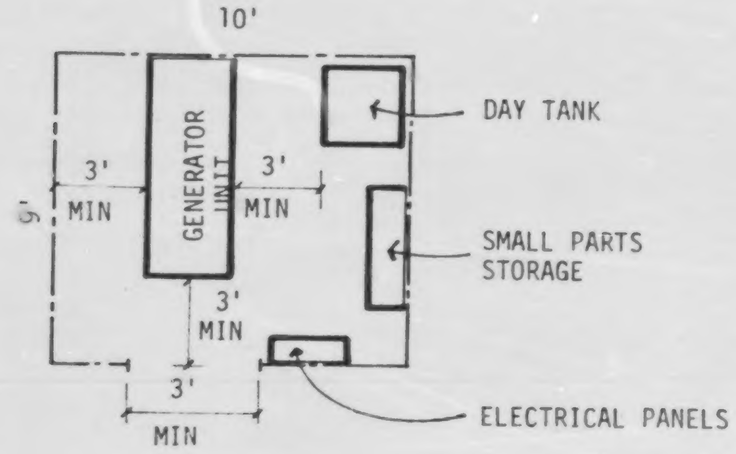
SERVICE REQUIREMENTS

Electrical:

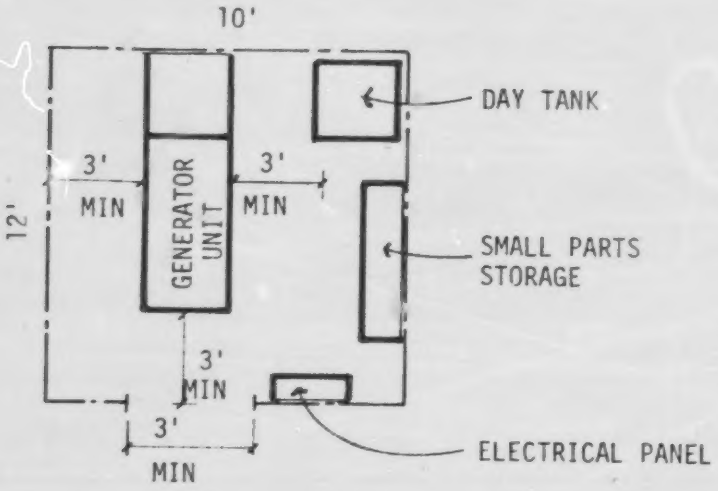
1. Power: Convenience outlets located around perimeter of generator building, approximately 10 feet on center. Convenience outlets over workbench. Power for jacket water tank heater.
2. Lighting: 20-30 FC, general lighting; 70 FC task lighting over workbench.

Mechanical:

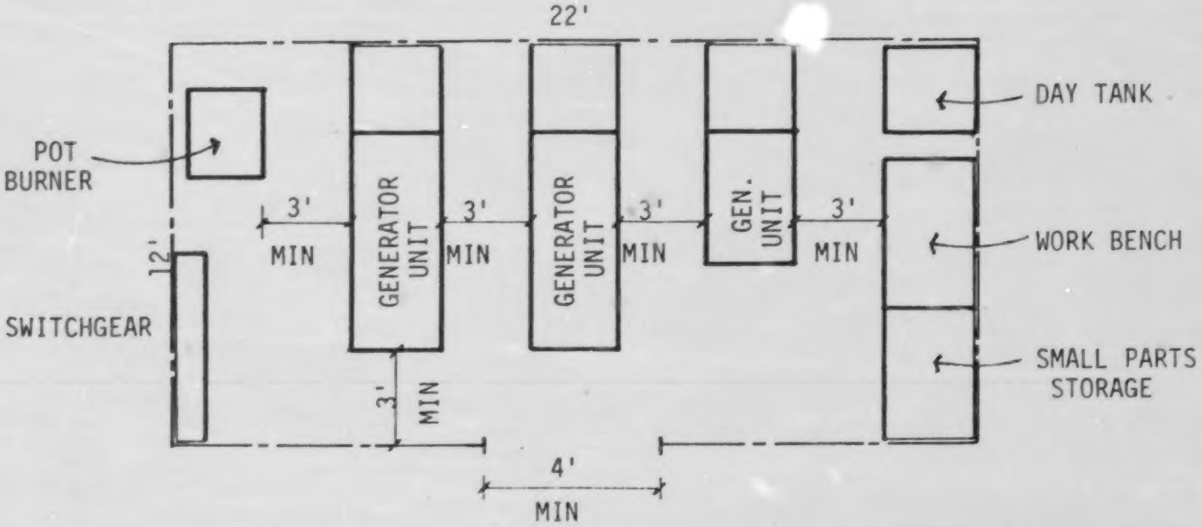
1. Fuel supply.
2. Cooling air for generator and jacket water, combustion air for engine.
3. Waste heat equipment (Level Three).
4. Fire Suppression: Halon or CO2 system.


10'
9'
3'
MIN
GENERATOR UNIT
3'
MIN
DAY TANK
SMALL PARTS STORAGE
3'
MIN
3'
MIN
ELECTRICAL PANELS

LEVEL ONE


10'
12'
3'
MIN
GENERATOR UNIT
3'
MIN
DAY TANK
SMALL PARTS STORAGE
3'
MIN
3'
MIN
ELECTRICAL PANEL

LEVEL TWO


22'
POT BURNER
DAY TANK
3' MIN
GENERATOR UNIT
3' MIN
GENERATOR UNIT
3' MIN
GEN. UNIT
3' MIN
WORK BENCH
12'
SWITCHGEAR
SMALL PARTS STORAGE
3' MIN
4' MIN

LEVEL THREE

SUPPLEMENTARY SPACE

14. WATER UTILITY

Schools in this size range are usually located in villages without a central piped distribution system. Development of an individual water source is required.

Regardless of the source, space allocation for water utility pressurization, treatment, and pumping will be necessary. The location of a water utility area should be on the main floor and easily accessible. Daily monitoring of treatment is necessary. If located on an upper level, access shall be by a full-sized stairway. Space set aside for storage of chemicals and replacement/repair of mechanical equipment should be analyzed by the architect. Many villages have annual delivery service only by barge, and high air freight delivery costs should be compared to the initial cost of providing annual storage space for items needed to maintain the water utility.

Protection from freezing is mandatory. Failure of the water system may not stop operation of the teaching program, but will result in loss of capital investment as well as providing a hardship. The occurrence of communicable disease is high in those villages without a central system. Often, the villagers look to the school as the only safe potable water supply. Space set aside for storage of chemicals and replacement/repair of mechanical equipment should be analyzed by the architect. Many villages have annual delivery service only by barge. High air freight delivery costs should be compared to the initial cost of providing annual storage space for items needed to maintain the water utility.

Design of the system for a maximum six-year projected enrollment will allow for reasonable future expansion. A minimum of 15 gallons per student and 25 gallons per teacher per day is a recommended minimum where water source availability permits.

Use of storage tanks as a wintertime storage supply will require additional space for heating equipment that provides freeze protection. Sizing of the tank should be based on the longest expected freezing time of the source, with an additional buffer for concentration of contaminants at the bottom of the tank.

Connection of the water supply to the building should take the differential movement of each into consideration. Use of insulated flexible connections is recommended.

PHYSICAL CHARACTERISTICS

Size: Varies with equipment used; minimum 18 square feet.

Ceiling Height: 7.5 feet minimum

Materials:

1. Walls: High light reflectance, washable. Chemical resistance in storage areas.
2. Ceiling: High light reflectance, washable.
3. Floors: Impermeable, noncombustible depending on heating equipment used for equipment room or storage tanks.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Heating: Above freezing.
2. Plumbing (site-specific).
3. Supplementary fuel supply.
4. Chlorination system.
5. Cartridge filtration system.

SUPPLEMENTARY SPACE

15. WASTE WATER DISPOSAL

Connection of the building sewer line to an existing sewer system should take no additional space when a gravity sewer service line is used. If a pump is necessary to move the sewage into the existing utility, then a sump may be required at some point in the building, probably below floor elevation. Sump pumps may also be required for moving sewage to a treatment plant or septic tank. Sumps could be located with easy and complete access through the floor from "supplemental" space above. The enclosure for sumps must be very well insulated with nonmoisture susceptible insulation; additional heat may be needed here as it is at a low elevation within the building.

Septic tanks are usually installed outside the building and underground; thus, they would require no space within the building. Other similar alternatives such as a lagoon or pond disposal would require no building space other than a possible sump pump as stated above.

Nonwater-borne waste disposal, as found in chemical, humus, or incinerating toilets, may need additional space to allow proper handling of wastes such as holding tanks and "honey buckets". Special access to such toilets may be desirable from an aesthetic point of view. Methods of collecting such waste may dictate location in the building.

When a sewage treatment plant within the building is deemed the best solution, additional storage space will be required for chemicals used in treatment. The frequency of delivery of such chemicals will dictate the amount of storage required.

Capacity for future expansion can be adequately handled by designing for a projected enrollment as discussed in Section 6.2. The size of the treatment plant listed below is based on 15 gallons per capita per day for schools without multipurpose rooms and showers, and 25 gallons per capita per day for schools with multipurpose rooms and showers.

PHYSICAL CHARACTERISTICS

Size: Minimum available. Individual home-type: 4' x 8' for equipment with clearance for maintenance; 80 square feet total.

Ceiling Height: Depends on type of unit. If pumps must be lifted above tanks for maintenance and repair, ceiling height may need to be as much as 114 feet.

Materials:

1. Walls: Good light reflectance, washable, chemical resistant.
2. Ceilings: Same as walls.
3. Floors: Impermeable, sloped to drain with emergency overflow provisions.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: To handle up to two HP, two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Temperature: 55-70 degrees F.
2. Plumbing: To handle flows.
3. Heating: Separate from rest of building.
4. Ventilation: Separate from rest of building.
5. Chlorination: Usually in tablet form; no power required.

General: Space requirements for packaged sewage treatment plants will vary with models available. Sizes are not standardized. Different methods of treatment would dictate size also. "Batch" treatment requires waste water storage at beginning of process, which may increase the space requirement. Sizes of packaged treatment plants are usually supplied in increment sizes that would accommodate more than one size of school.

SPACE SUMMARY:

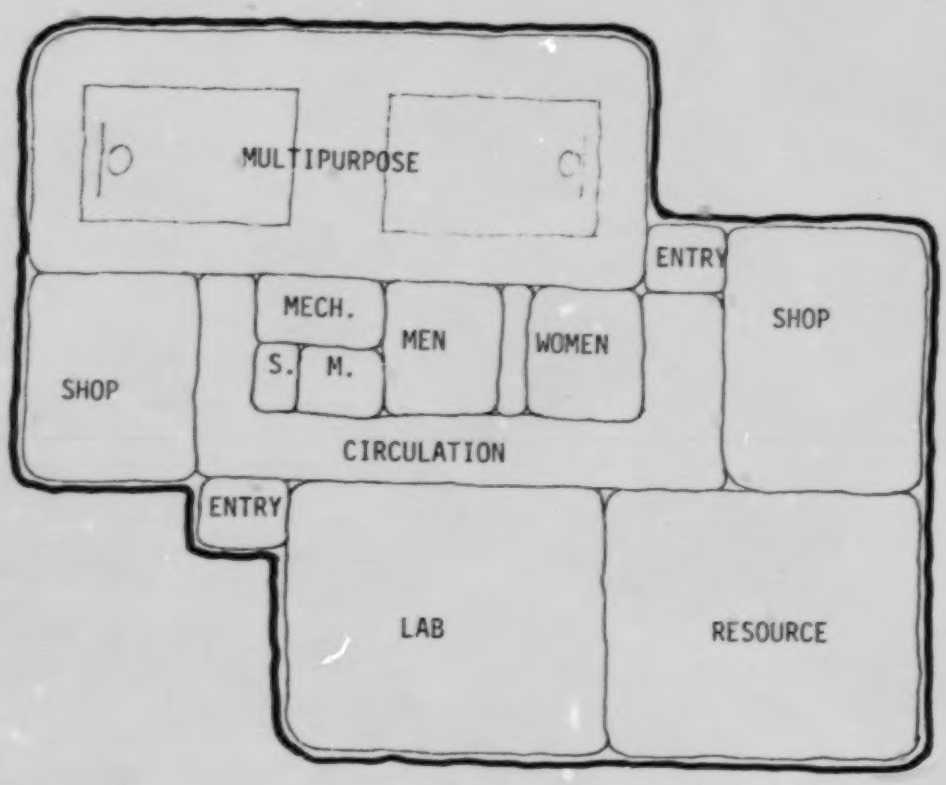
Student Enrollment	1-10
Classroom(s)	800 1/
Library/Media Center (% of Individual Study Space)	
Science Classroom	
Office	
Business Education	
Home Science	
Industrial Education	
Multipurpose Space	
Supplementary Space	300 (27% of Gross)
Restrooms Mechanical Space Wall Thickness Storage	
TOTAL	1,100 S.F.

1/ Includes wet area for Science/Home Economics.

The secondary school for 11-20 students will be a total facility of approximately 4,455 square feet, of which 3,300 square feet will be designed for various high school programs and approximately 1,155 square feet will be needed for supplementary space, e.g., toilets, maintenance room, mechanical room, and general storage.

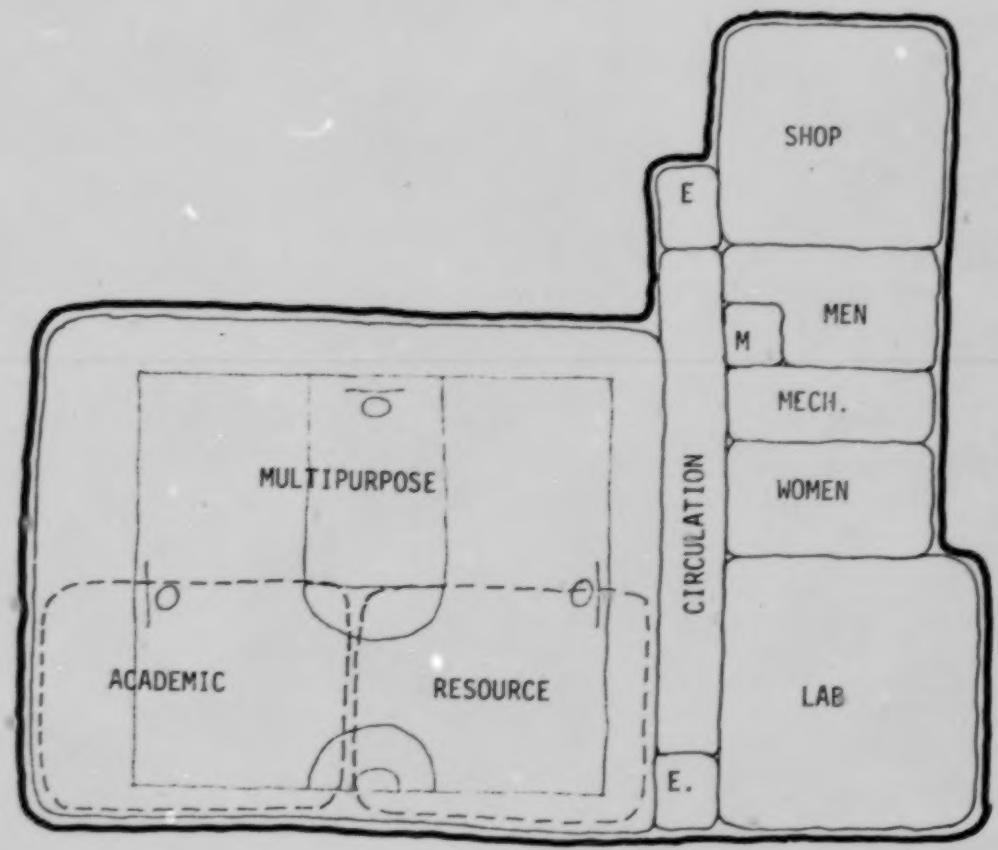
A school of this size will be staffed by one or two teachers, depending on school district policy and availability of funds. For planning purposes, allow space for two. Besides functioning as a teacher, one staff member will also function as the principal and assume responsibility for total operation of the school program and facility.

Program requirements, activities, and space requirements will influence the division of assignable space into program areas. A local or district desire to increase potential multipurpose area could be accomplished by combining academic, resource, and multipurpose spaces together, forming a flexible plan as shown in the following illustration. While this will increase space available for recreation, there will be a trade-off for acoustics and a traditional classroom atmosphere.



TRADITIONAL PLAN

A traditional plan is illustrated showing the relationship of spaces as allocated by the DOE guidelines.



FLEXIBLE-USE PLAN

Acoustical separation of noise-producing areas, such as the shop from classroom areas, is achieved in the conceptual plans by remotely locating the two activities. Service cores and corridors can be utilized as buffers between acoustically noncompatible program areas.

The extent of the food service program will be determined by each school district. Whether or not a food service program is provided, and to what extent, will have major effects on the allocation of space, sizing of mechanical systems, selection of materials, and general layout of the school plan.

Site utilities, e.g., water, waste water, power generation, are additional program items that must be incorporated into the design as determined by specific site conditions.

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Science	Students dissecting various animals and plants; performing chemical experiments; mixing fuming chemicals; sorting, categorizing and storing various rocks, plants, animals, and sea life, and putting them in display cases; viewing films.	Lab (Project Area)
Math	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 1-10: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Language Arts	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips.	Academic Area

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Language Arts (Con't.)	Discussion: Groups of 1-10: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area (Con't.)
Social Studies	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 1-10: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Physical Education	Description of Activities: Passive: Total class or total school holding assemblies, viewing movies and/or stage plays.	Multipurpose

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Physical Education (Con't.)	Individual Skill Practice and Dual Sports: Groups of 5-20 practicing skills and participating in fitness and related physical education activities (e.g., wrestling, calisthenics, gymnastics, table tennis, shuffleboard, four-square, weight training, etc.). Team Skills: Groups of 5-20 practicing skills and participating in team activities (e.g., basketball, floor hockey, volleyball, flag football, soccer, softball, etc.). Community Use: Passive: Total community viewing of movies, watching plays and holiday programs; holding community meetings; dancing; festivals. Individual and Team Sports: Various groups from the community participating in fitness and related physical education activities and team sports (e.g., basketball, shuffleboard, weight training, volleyball, softball, etc.).	Multipurpose (Con't.)

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Electives:		
Home Science	Small groups of students working in the four skill areas of cooking, sewing, homemaking, and child care, as well as passively reviewing TV and films as a group, and slide and/or film-strips; cassette tape presentations as a group or as individuals. Cooking: Frying, baking, mixing, washing dishes, measuring, cooking, freezing. Sewing: Measuring, laying out, sewing, cutting, pressing or ironing, etc. Homemaking: Interior design, entertainment, food storage, family living, cleaning, washing and drying clothes, home nursing. Child Care: Dressing, feeding, holding, entertaining, observing.	Lab (Project Area)
Business Education	Typing: Students will in general be working individually or in groups of 1-5. Students will learn individually studying in carrels using slide-tape machine and typewriters.	Sound Module or Lab

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Business Education (Con't.)	Office Practice: Students will learn and work individually with various office machines.	Sound Module or Lab (Con't.)
Music	1) Performing: (a) Singing (b) Playing instruments, optional w/sound module. 2) Listening 3) Creating	Academic Area
Art	1) Painting 2) Drawing 3) Pottery Making 4) Carving 5) Printmaking 6) Constructing 7) Forming 8) Weaving 9) Etching.	Lab (Project Area)
Trade & Industries	Assembling, disassembling small engines; measuring, sawing, fitting, gluing, nailing, sanding, building, blueprint reading, drafting; welding/metals optional.	Shop

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Library/Media	The focus of the academic area is envisioned to be the learning resource center. It is the depository for teaching resources and a space for individual learning. It should be readily accessible to individuals and groups and should be closely related to specialized learning laboratories. One of the major components in the learning resource center which can bridge both learning and social differences between remote areas and the outside world is the audio-visual information center. Here a well-supplied source of learning materials can bring the world of today into the classroom for all students.	Resource Area w/Carrels
Auxiliary Services:		
Administration	Counseling students individually or in small groups; greeting and/or talking to parents and other groups; filing reports, and permanent records; typing reports, conducting phone and radio communications, duplicating of teaching material, and testing.	Teacher Office Area/Administration
Food Service	Extent of activity to be determined by school district and availability of other existing facilities.	Lab or Food Service Area; Storage - Cold and Dry

1. ACADEMIC AREA

The academic area should provide for conventional educational experiences but should be flexible enough to accommodate changes in enrollment, learning-group sizes, activity requirements, and teaching methods. The academic area should provide for instruction in the following program areas: math, social studies, language arts, music, and other electives.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Material: (Quality)

1. Walls: High light reflectance.
2. Floors: Acoustic; color should resist effects of soiling.
3. Ceiling: Acoustic.

Windows: Windows are desirable to provide psychological relief, back-up ventilation, and emergency exits, but their use must be limited to minimize heat loss and potential distraction.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at desks and chalkboard.
2. Power: Two outlets or power poles on each wall.
3. TV jack.
4. Clock (battery).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Math:

Item No.	Equipment List
a.	Chalk and tackboards
b.	Student seating (1-15); desks or tables
c.	Overhead projector
d.	Tape recorder with headsets
e.	Math lab supplies kit
f.	Calculators (hand)
g.	Projection screen (wall or ceiling mounted)

Special Requirements:

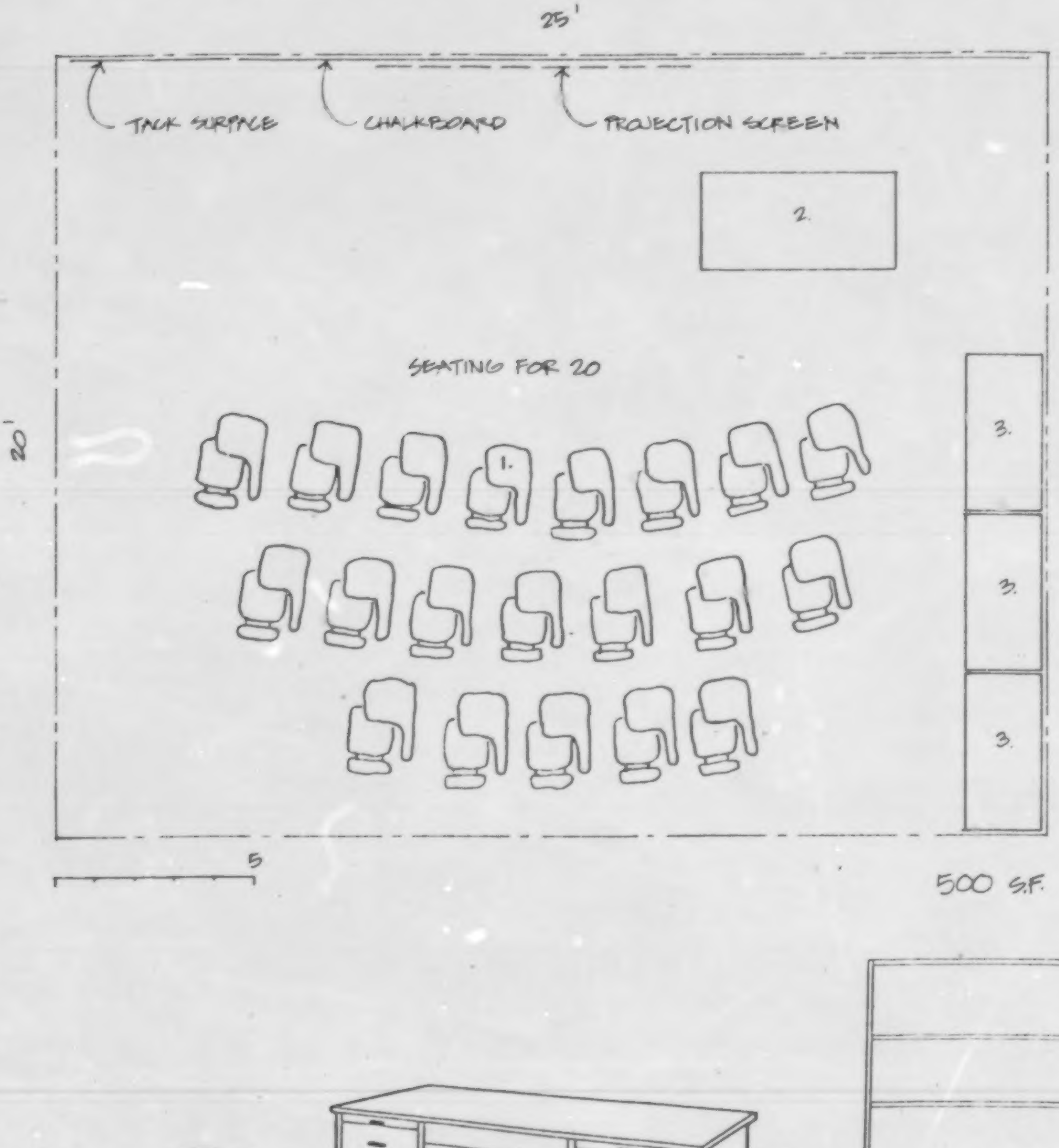
1. Power strip.
2. Project storage space (tote trays).
3. TV jack.

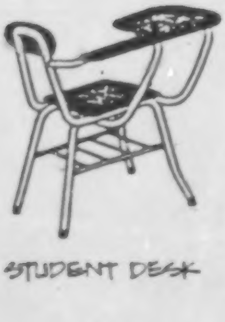
Language Arts:

Item No.	Equipment List
a.	Same as Math (not including calculators)

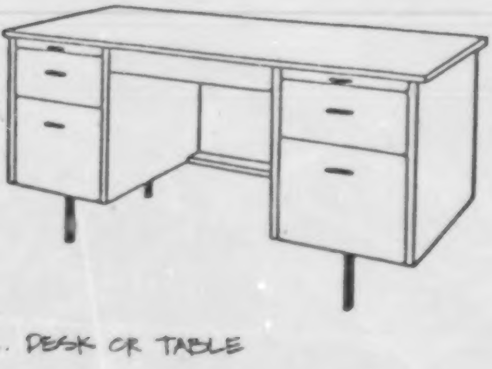
Social Studies:

Item No.	Equipment List
a.	Same as Math and Language Arts

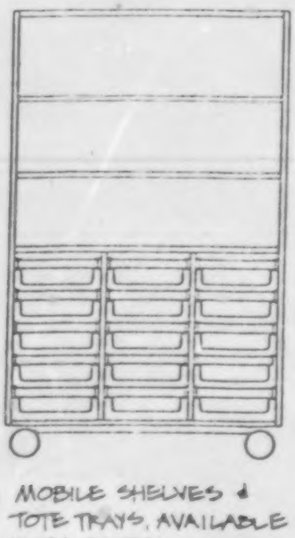

25'
TACK SURFACE
CHALKBOARD
PROJECTION SCREEN
2.
SEATING FOR 20
1.
3.
3.
3.
20'
5
500 S.F.



1. STUDENT DESK



2. DESK OR TABLE



3. MOBILE SHELVES & TOTE TRAYS, AVAILABLE WITH DOORS

2. LAB (PROJECT AREA)

The lab (project area) for the 11-20 enrollment group should be designed to accommodate science, home science, and art programs. This area might also be used by business education, and a food service program. However, if the food service program is to be included as a part of the lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. This facility should allow for ease in adaptation from one program to another. Careful planning for storage of all equipment and student projects for each activity, along with the specification of multiuse counter areas, will be necessary to achieve a functional design.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: (Quality). One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable (e.g., V.A.T.).
3. Ceiling: Washable.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at counter and table tops.
2. Power:
    a. Plugstrip around walls above countertop.
    b. 120/208-V., 3-phase.
    c. TV jack.

Mechanical:

1. Ventilation: Noxious fume exhaust; rangehood exhaust.
2. Plumbing:
    a. Hot and cold water.
    b. Acid-resistant waste pipes (Science).
    c. Plaster trap in sink (Art).
    d. Gas for Bunsen burner desired (Science).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Science:

Item No.	Equipment List
a.	Mobile student science cart
b.	Science table w/acid-resistant top and 4 stools (2)
c.	Microscope (4)
d.	Plant study kit
e.	Electricity kit
f.	Simple machines kit
g.	Weather station
h.	Aquarium, 10 gallon
i.	Terrarium, 10 gallon
j.	Scale and spring balance, 15 kg. capacity (2)
k.	Rock and mineral collection
l.	Dissecting set (advanced type for 8)
m.	Hot plate - 660 W., single unit (2)
n.	Ammeter
o.	Pump (hand-air vacuum and pressure)
p.	Basic set of chemicals (provide locked storage)
q.	Assorted test tubes and flasks
r.	Assortment of science charts
s.	Project storage

Special Requirements:

1. Storage cabinet with locking doors.
2. Sink (chemical and abrasion resistant).
3. Noxious fume exhaust.
4. Bunsen burner hook-up (desired).
5. Built-in display cases (desired).
6. Electrical outlets: minimum of 4, plugstrip desired.
7. Chalk and tackboard.
8. Storage for flammable materials.

Home Science:

Item No.	Equipment List
a.	Kitchen range, 4 burner stove
b.	Double sink
c.	Base cabinets with counter
d.	Overhead storage cabinets
e.	Assortment of small appliances (storage space to be provided)
f.	Portable sewing machine (4)
g.	Table with 4 chairs (2)
h.	Fitting mirror

i.	Dressing area (curtains)
j.	Ironing board and storage (2)
k.	Tote drawer cabinet
l.	First aid kit
m.	Washer/dryer (optional)
n.	Assorted dishes, pots, and pans
o.	Refrigerator/freezer
p.	Microwave oven (optional)
q.	File cabinets
r.	Food and staples storage

Special Requirements:

1. Plugstrips.
2. 140 degree hot water (desirable).
3. Chalk and tackboards.
4. TV jack.
5. Vent hood.

Art:

Item No.	Equipment List
a.	Table with 4 chairs (2)
b.	Drawing boards (8)
c.	Easel (2)
d.	Assortment of supplies
e.	Project storage
f.	Double sink with plaster trap
g.	Display space
h.	Chalk and tackboards

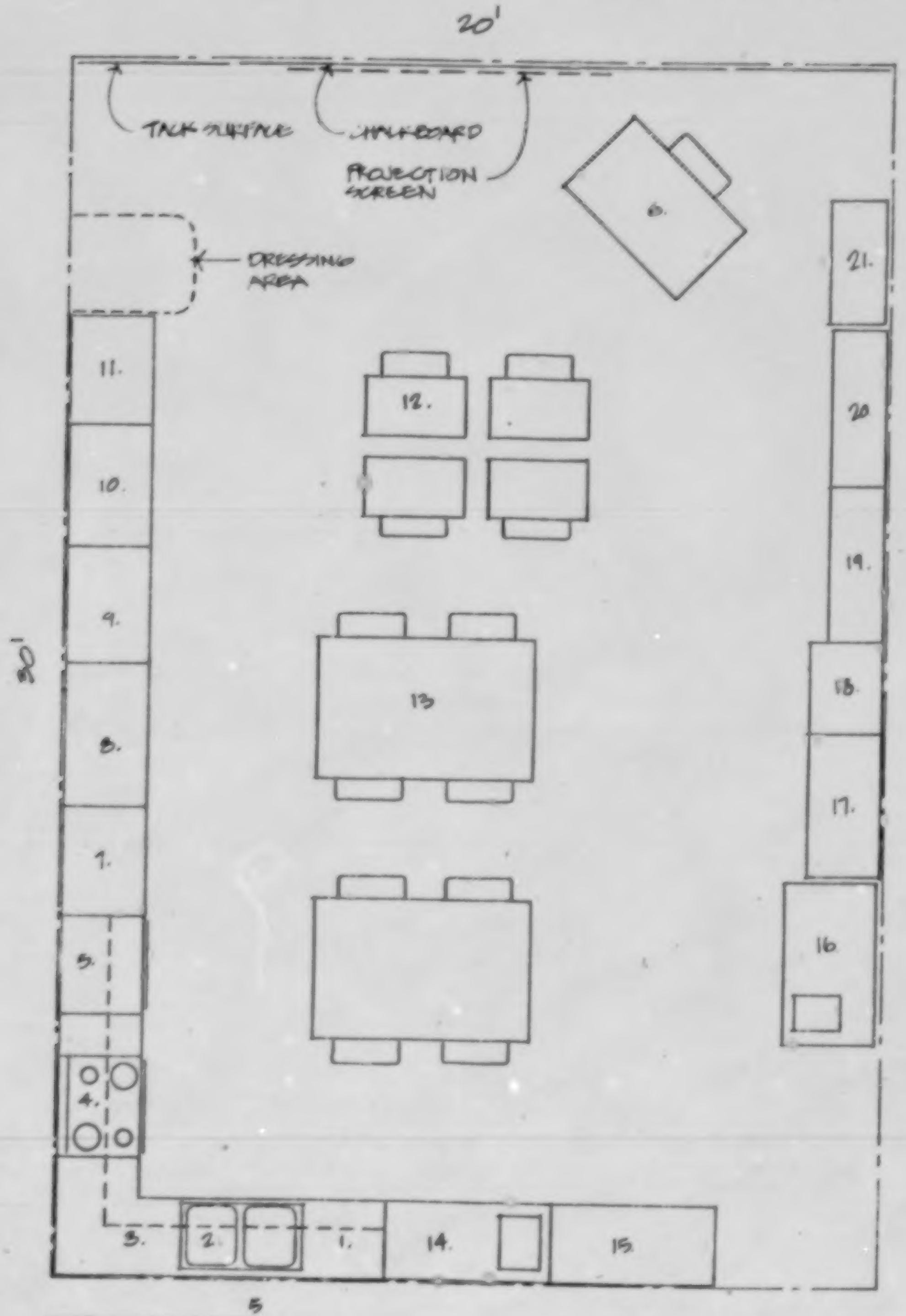
Food Service:

Item No.	Equipment List
a.	Stove
b.	Microwave oven (optional)
c.	Refrigerator/freezer
d.	Food, utensil, and paper storage
e.	Sink

Business Education:

Item No.	Equipment List
a.	Typewriters (2)
b.	Office machines, e.g., adding machine, printing electric calculator, duplicating machine
c.	Chalk and tackboards
	Special Requirements:
1.	Acoustic treatment.

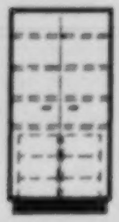
LAB (PROJECT AREA)


20'
TACK SURFACE
CHALKBOARD
PROJECTION SCREEN
DRESSING AREA
6.
21.
11.
12.
20
10.
19.
9.
30'
13
18.
8.
17.
7.
5.
16
4.
3.
2.
1.
14.
15.
5

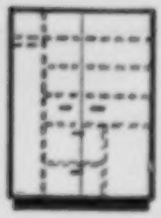
600 S.F.

HOME SCIENCE

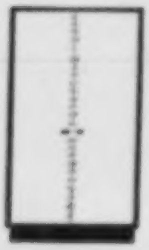
1. BASE CABINETS W/COUNTER
2. STAINLESS STEEL SINK
3. WALL HUNG CABINETS
4. 4 BURNER RANGE
5. REFRIGERATOR/FREEZER
6. TEACHER'S DESK OR TABLE



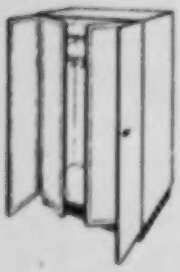
7. FOOD & STAPLES



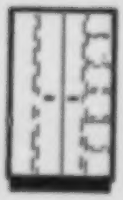
8. MISC. STORAGE



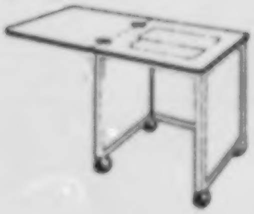
9. TOTE TRAYS (28)



10. FITTING MIRROR & WARDROBE

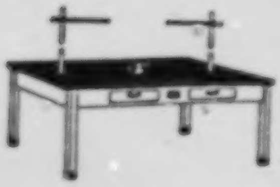


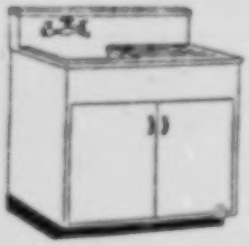
11. IRONING BOARD STORAGE

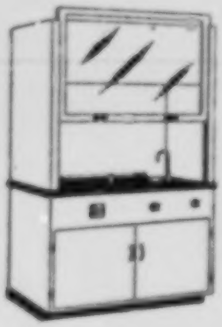


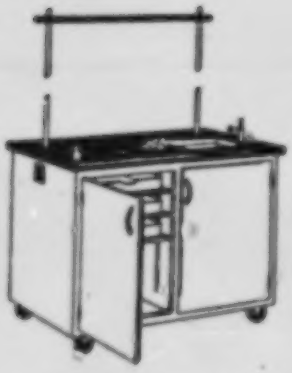
12. SEWING MACHINE TABLE

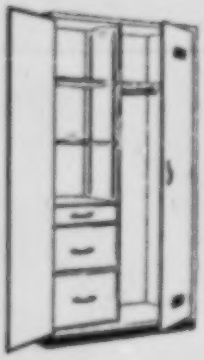
SCIENCE

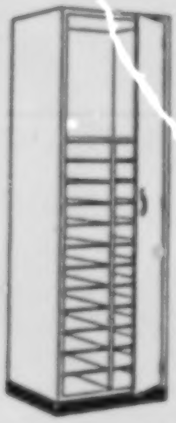

13. 4-STUDENT TABLE

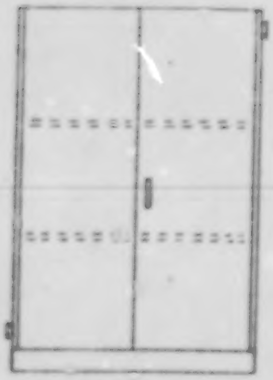

14. WALL SINK

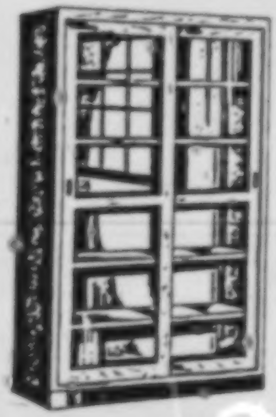

15. FUME HOOD

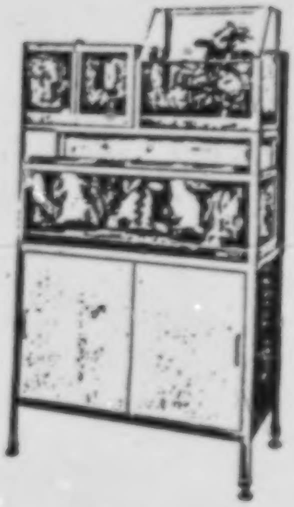

16. MOBILE INSTRUCTOR'S DESK


17. WARDROBE & SUPPLY


18. TOTE TRAYS


19. FLAMMABLE STORAGE


20. STORAGE & DISPLAY


21. BIO LAB

3. RESOURCE AREA

The resource area is the focal point of the educational environment in the small high school. This area will be used primarily for individualized study, but may also be used for instruction and to provide for an informal seating and meeting area. This area will be the primary depository and distribution point for educational materials and equipment, e.g., books, tapes, films, projectors, recorders, etc.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials:

1. Walls: High light reflectance; acoustic.
2. Ceiling: Acoustic.
3. Floors: Acoustic; color selection to minimize effects of soiling.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: Variable; 70 FC on desks in reading/study area.
2. Power: Plugstrip around walls and power poles in center to provide power for carrels.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

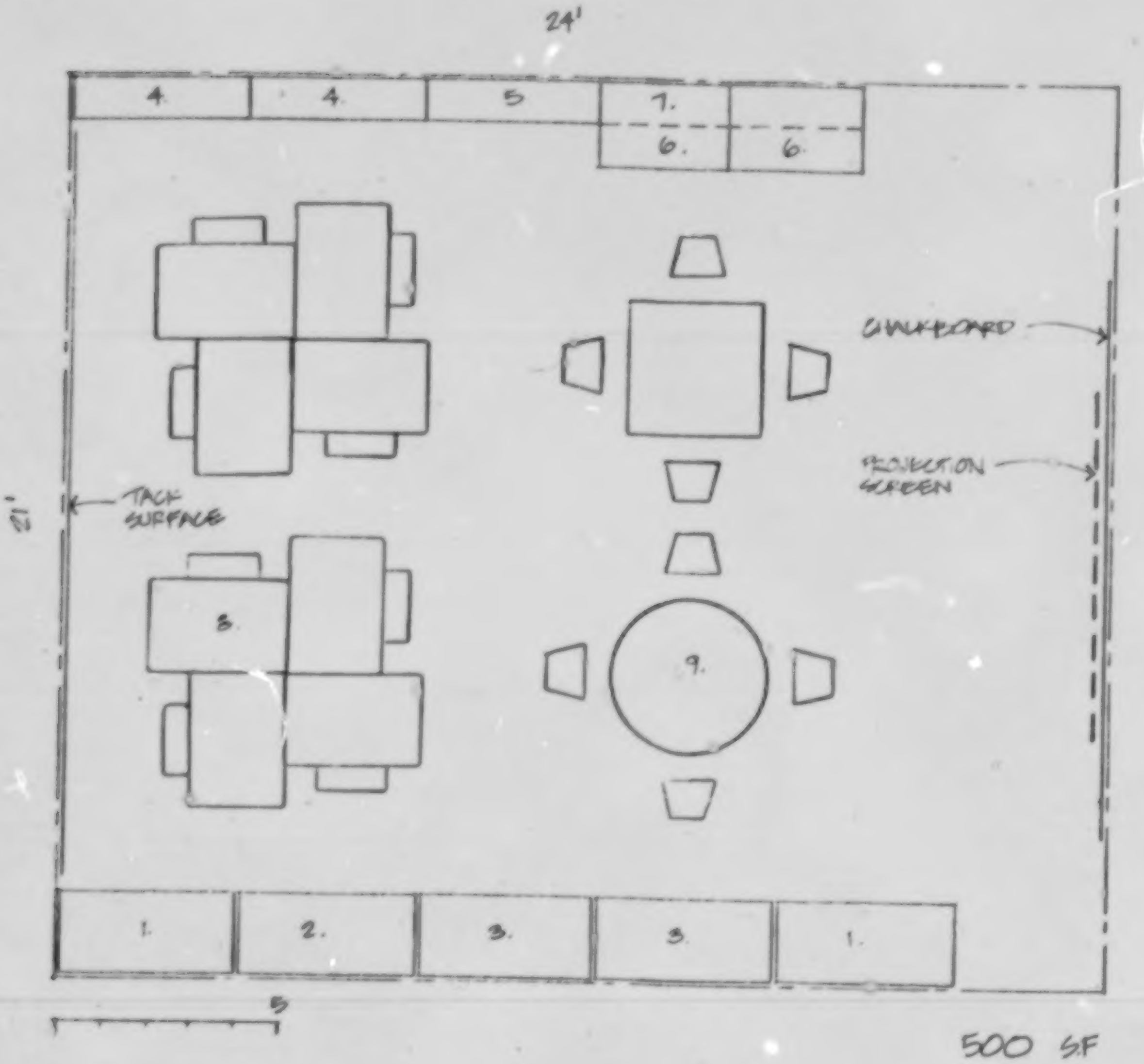
Library/Media:

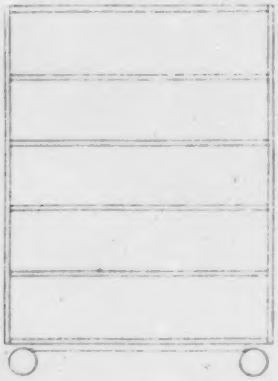
Item No.	Equipment List
a.	Seating for (15)
b.	Carrels (8)
c.	Books and periodical storage
d.	A/V equipment storage: - 16 mm. projector - 35 mm. slide/filmstrip projector - Overhead projector - Microfilm viewer - Video-tape recorder/player - TV camera - Cassette and video-tape storage
e.	TV jack

Special Requirements:

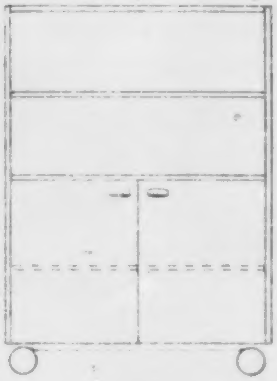
1. Power plugs or poles.
2. Task lighting.

CONCEPTUAL LAYOUT RESOURCE AREA

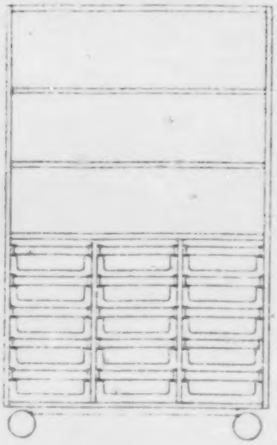

24'
4
4
5
7.
6.
6.
CHALKBOARD
PROJECTION SCREEN
TACK SURFACE
21'
8.
9.
1.
2.
3.
3.
1.
5
500 SF



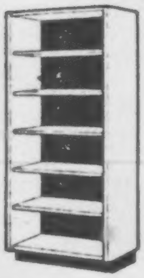
1. MOBILE BOOKSHELF



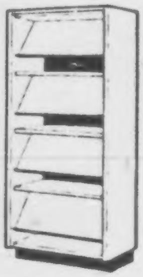
2. MOBILE BOOKSHELF & CABINET



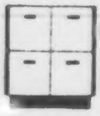
3. MOBILE BOOKSHELF & TOTE TRAYS



4. BOOKSHELF

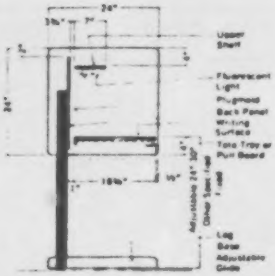


5. MAGAZINE SHELVING



6. FILE CABINET

7. WALL CABINET


24"
7"
Upper Shelf
Fluorescent Light
Plugmold
Back Panel
Writing Surface
Tote Tray or Pull Board
24"
18½"
1"
Adjustable 24"-30"
Leg Base
Adjustable Glide

8. STUDY CARREL

9. TABLE & CHAIRS

4. SOUND MODULE

An expandable, movable sound module might be provided for use in coordination with business and music programs and may also serve as a private area for study or small meetings. The use of an independent module would provide an excellent space for acoustically isolating certain activities.

PHYSICAL CHARACTERISTICS

1. As specified.

SERVICE REQUIREMENTS

Electrical:

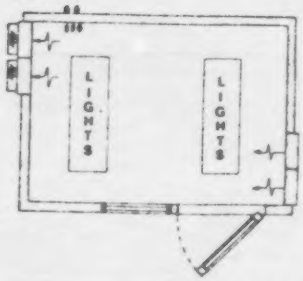
1. Power: Hook-up.

Mechanical:

1. Hook-up as specified.

CONCEPTUAL LAYOUT

SOUND MODULE



5. MULTIPURPOSE ROOM

The multipurpose room should be designed to accommodate a wide range of both school and community activities that will include:

1. Physical Education
2. General Assembly
3. Theater
4. Dancing
5. General Indoor Recreation
6. Community Meetings and Events
7. Food Service (Cafeteria)
8. Spectator Activities.

To gain additional multipurpose space in the 11-20 enrollment group, space for academic and resource programs might be added to the multipurpose room and planned for flexible use. A folding acoustic wall and athletic floor carpet might be provided to allow the space to function as a classroom and multipurpose room concurrently. This arrangement will require more effort for both the students and faculty to set up, but will provide the largest recreational space allowed within the DOE guidelines.

The multipurpose room should be located in close proximity to both locker room and toilet areas. Adequate equipment storage should be provided. This storage room might be designed to be the control point for administration and distribution of equipment for after-hours use. Special consideration should be given in the design phase to adequately plan for the storage of such items as wrestling mats, volleyball standards, and gymnastic equipment. This facility may be used by students and the community after school hours; therefore, to aid in after-hours administration, the facility should be designed to allow classroom areas and equipment to be secured while the multipurpose area is in use. If the facility is to be jointly used by elementary students, access and acoustical separation should be provided to avoid disruption of the secondary school program.

PHYSICAL CHARACTERISTICS

Size:

1. 1,200 square feet (traditional program).
2. 2,000-2,900 square feet (adding classroom area to multipurpose room and providing acoustic separation).

Ceiling Height: 20 feet minimum.

Materials:

1. Walls: High light reflectance; acoustic; flush walls desirable.
2. Ceiling: High light reflectance; acoustic.
3. Floor: Maintainable; acoustic material (depends on programmed usage).

Windows: Not recommended.

SERVICE REQUIREMENTS

Electrical:

1. Lighting:
   a. 50 FC; multilevel lighting through multiple switching.
   b. 70 FC in areas to be used for classroom.
   c. Guarded fixtures.

2. Power:
   a. Battery operated clock.
   b. Public address system.
   c. Miscellaneous outlets.

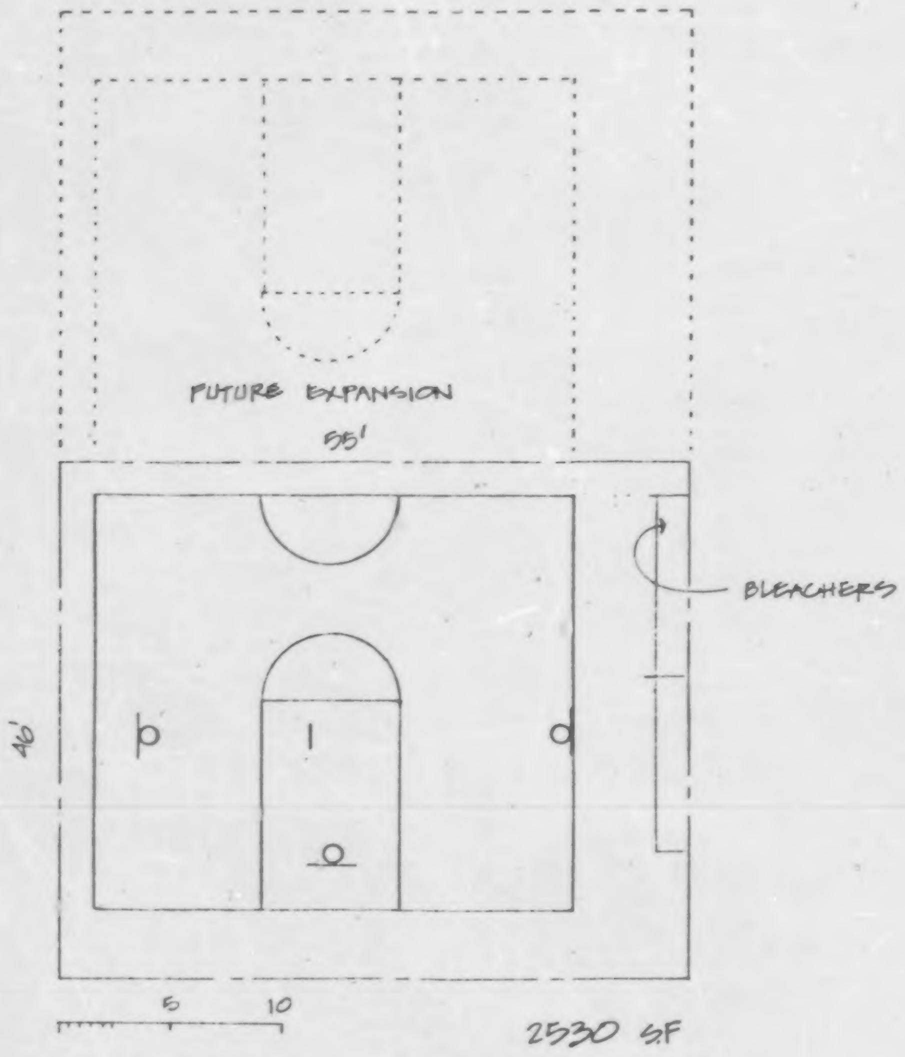
Mechanical:

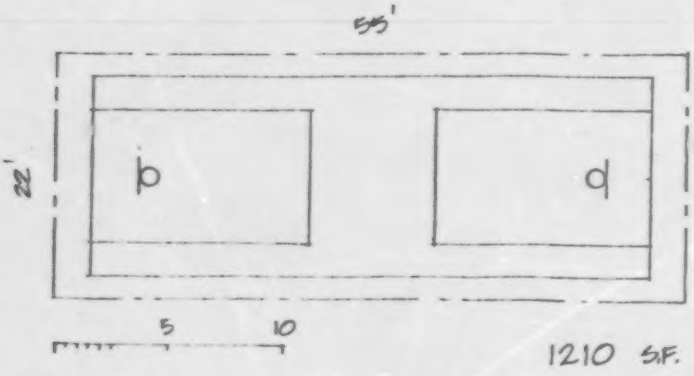
1. Heating: 60-72 degrees F.
2. Ventilation: As required for greatest use demands.
3. Plumbing: As required by academic program.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Physical Education:

Item No.	Equipment List
a.	Tumbling mat (6 x 12 Ensolite) (1)
b.	Climbing rope
c.	Weight set
d.	Assortment of balls
e.	Basketball standards
f.	Volleyball standards
g.	Floor hockey equipment
h.	Wrestling mat
i.	Gym-scoots


FUTURE EXPANSION
55'
46'
BLEACHERS
5
10
2530 S.F


1210 S.F.

6. SHOP

The Trades and Industries (T & I) program will be a program area of major interest in bush villages. To an extent, the industrial education program in small high schools will be limited by the size of the facility, equipment, and fire code limitations. The thrust of the industrial education curriculum will be determined on a local and district level; the desired program space available and equipment layout must be closely coordinated with the designer to arrive at a realistic and functional arrangement. A Ken Cook Trans-national Learning Station will be utilized to supplement the desired program.

PHYSICAL CHARACTERISTICS

Size: 400 square feet.

Ceiling Height: 10-12 feet.

Windows: 7'-6" minimum from floor, or eliminate.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: High light reflectance; acoustic; fire resistant, as required.
2. Floors: Durable, nonabsorptive, nonskid (e.g., concrete topping is desirable; thin-set quarry tile or end grain wood is an alternate).
3. Ceiling: High light reflectance; acoustic.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC in work areas; guarded fixtures.
2. Power: 120/208-V., 3-phase; separate panelboard for industrial education power equipment with shunt trip main breaker or contactor controlled by emergency shutdown buttons.

Mechanical:

1. Heating: 67 degrees F. (to minimize injuries).
2. Ventilation: 5 CFM OSA/person, minimum. ASHRAE 62-73; plus special E/A requirements.
3. Woodshop: Sawdust collection requirements.

4. Metal Shop: Recirculating air purifier can be used for welding fumes.
5. Paint Finishing: Strict fire code requirements to be resolved in design.
6. Power Mechanics: Hazard area with special requirements.
7. Plumbing:
    a. Waste: Sand, grease, oil, solids interceptor; floor drains.
    b. Water: Sink with tempered water.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Industrial Education:

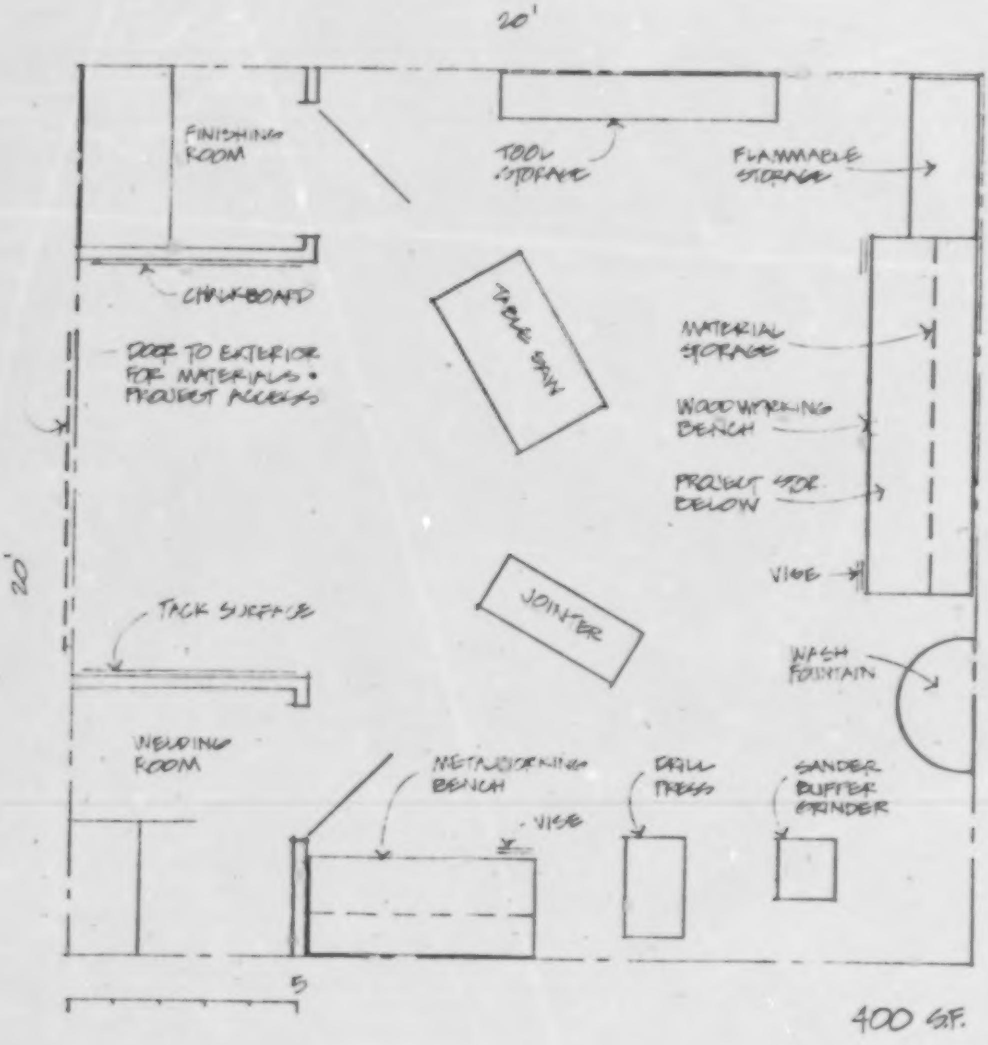
Item No.	Equipment List
a.	Chalk and tackboard
b.	4-student workbench (1)
c.	Drill press, 15" variable speed, w/1/2 HP motor (1)
d.	4" jointer w/1/3 HP motor (1)
e.	Table saw (1)
f.	Vise, machinist, swivel base, 5" jaw, opens to 6-1/2" (1)
g.	Builders saw, 7-1/4" (1)
h.	Bayonet saw kit (1)
i.	Belt sander, 3" x 21" (1)
j.	Disc sander, 7", 2/5/8 shaft (1)
k.	Drill, multispeed reversing, 1/2" (1)
l.	Drill, multispeed reversing, 1/4" (1)
m.	Miter box, 2/24 x 24" saw (1)
n.	Vise, woodworking, 4/10" jaw, open 12" (4)
o.	Tool storage cabinet (1)
p.	Ken Cook Trans-national Learning Station w/SR 100 A.V. desk (1)
q.	Assorted handbooks - both mechanics and woodworking (1)
r.	Welding booth (optional)
s.	Finish booth with exhaust
t.	Material storage
u.	Other equipment as program and space allow

Special Requirements:

1. Wash basin.
2. Dust exhaust system.
3. Flammable liquid storage.
4. Fire code requirements for separation, use, and storage of materials and equipment, and integration of T & I activities.
5. Acetelene and oxygen tanks for welding program should be stored on a movable cart and kept in a warm area. The performance of these gases, for welding purposes, is affected by extreme cold.
6. Exterior access for materials and projects (ramp, if above-grade).

CONCEPTUAL LAYOUT

SHOP


20'
FINISHING ROOM
TOOL STORAGE
FLAMMABLE STORAGE
CHALKBOARD
TABLE SAW
MATERIAL STORAGE
DOOR TO EXTERIOR FOR MATERIALS • PROJECT ACCESS
WOODWORKING BENCH
PROJECT STOR. BELOW
20'
VISE
TACK SURFACE
JOINTER
WASH FOUNTAIN
WELDING ROOM
METALWORKING BENCH
DRILL PRESS
SANDER BUFFER GRINDER
VISE
5
400 S.F.

7. TEACHER OFFICE AREA/ADMINISTRATION

The teacher in the small school is a person of many responsibilities and functions. Teacher office areas provided within academic, lab, or other programmed areas must be accessible to students and allow for maximum area observation. Space must be provided for secure storage of student records and funds, and the school radio or CB. A multiuse room might be provided that would serve as a teacher prep area, administrative office, and audio-visual storage.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: (Quality)

1. Walls: Acoustic.
2. Ceiling: Acoustic.
3. Floor: Acoustic.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC in work areas.
2. Power:
   a. Miscellaneous outlets.
   b. Radio, TV antennae, telephone jack.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

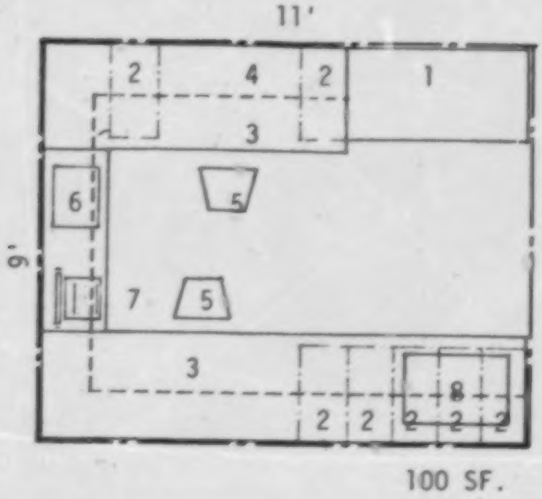
Administration:

Item No.	Equipment List
a.	Desk and chair (2)
b.	4-drawer file cabinet with lock (2)
c.	Bookshelves
d.	Small conference table (optional)
e.	Secure storage for student records and money
f.	Telephone/radio/CB
g.	Typewriter and stand
h.	Coffee Pot

Special Requirements:

1. Power strip.
2. Task lighting.

CONCEPTUAL LAYOUT TEACHER OFFICE AREA/ADMINISTRATION



1. A/V & VALUABLE STORAGE
2. FILE CABINET
3. COUNTERTOP WORK AREA
4. WALL-HUNG CABINETS & BOOKSHELVES
5. CHAIR OR STOOL
6. RADIO AND/OR CB
7. TYPEWRITER
8. DUPLICATING MACHINE

SUPPLEMENTARY SPACE — 8. TOILETS

The level of feasible service will be determined on a site-specific basis. Actual fixture counts will vary due to code interpretations, enrollment, utilization of facility, village population, and availability of water. In determining the number of fixtures required, consider the possibility of increased enrollment and community use. The following are facility recommendations for the 11-20 student enrollment group:

	Men		Women
Water Closets	1		1
Urinals	1		
Lavatories	1		1
Showers	1		1
Drinking Fountain		1	

PHYSICAL CHARACTERISTICS

Ceiling Height: 7.5 feet minimum.

Materials: (Quality)

1. Walls: Water resistant; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Water and wear resistant.

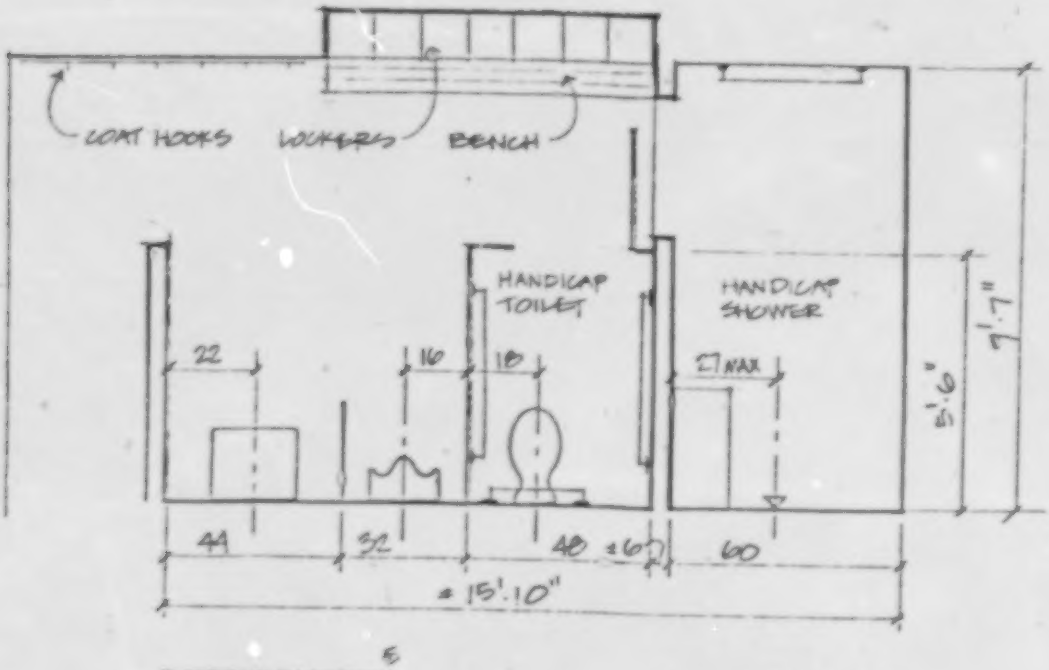
SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC; vapor-tight and vandalproof fixtures.
2. Power: Outlets ground fault protected.

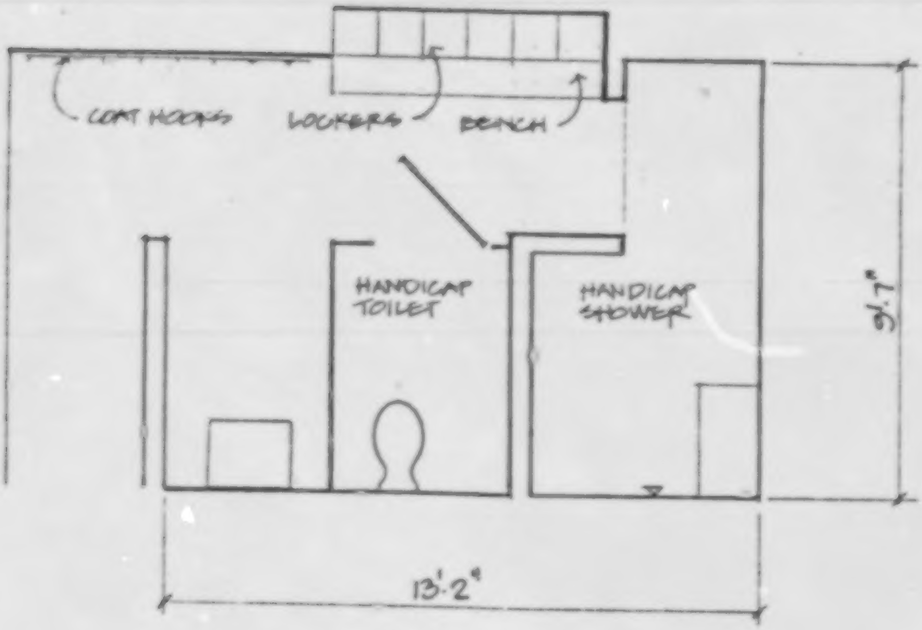
Mechanical:

1. Heating: 70-75 degrees F.
2. Plumbing (site-specific):
   a. Water - tempered.
3. Exhaust air.


COAT HOOKS
LOCKERS
BENCH
HANDICAP TOILET
HANDICAP SHOWER
22
16
18
27 MAX
44
32
48 ±6
2
60
± 15'10"
5'6"
7'7"
5

160 S.F.

MENS TOILET


COAT HOOKS
LOCKERS
BENCH
HANDICAP TOILET
HANDICAP SHOWER
9'7"
13'2"
5'

130 S.F.

WOMENS TOILET

SUPPLEMENTARY SPACE 9. MECHANICAL/ELECTRICAL AREAS

The mechanical room and electrical panel should be located on the main level and be easily accessible and close to an entry (not on an upper level or in an attic space).

The pending freeze-up danger and the unavailability of a local repair service with a spare parts inventory, increase the need for a well-planned mechanical/electrical room. It is very important to provide enough room in this space to easily service all equipment. Too often in the early stages of design, this area is established by the architect without adequate consultation with the mechanical and electrical engineers. The failure of one of these systems, and an inability to have ready access for diagnosis and repair, can result in serious damage to the facility and its contents and loss of a school program. However, the room should be planned to not have more space than is needed for equipment servicing (including major replacement); too much space will result in unauthorized storage of materials in this room (a code violation). Doors, knock-out panels, or some means of egress for the largest piece of equipment must be provided for future replacement. The electrical and control panels should be located so that the net clear space (minimum 30 inches by code) in front of them must be used for circulation space within the mechanical room. This helps to prevent the storage of materials in front of the panels (panels may be located elsewhere in the building with these guidelines applied).

PHYSICAL CHARACTERISTICS

Size: 8'-6" x 12'-6" minimum (will vary with equipment used).

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 808.

1. Walls: High light reflectance; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Combustible or noncombustible surface depending on fuel-fired equipment specified; noncombustible recommended to reduce fire hazard of absorbed fuel oil.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 20 FC.
2. Power: Two outlets; ground fault protected (minimum).

Mechanical:

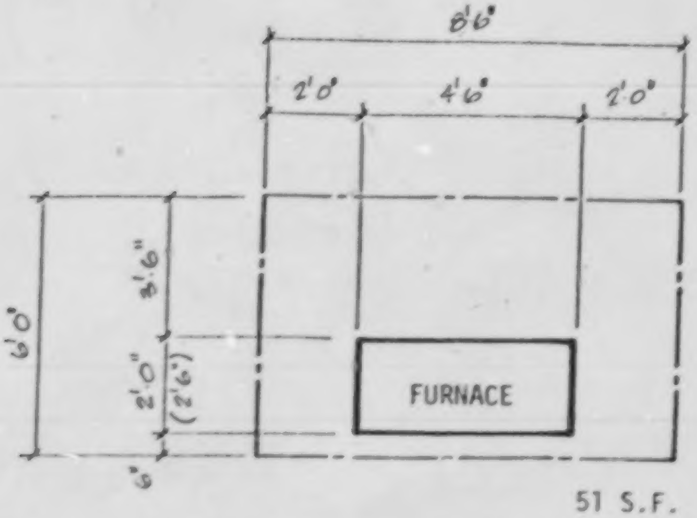
1. Fuel supply and day tank.
2. Two furnaces.
3. Hot water heater.
4. Space for offset chimney(s).

CONCEPTUAL LAYOUT MECHANICAL/ELECTRICAL AREAS

Building Size: 4,455 S.F.

Note:

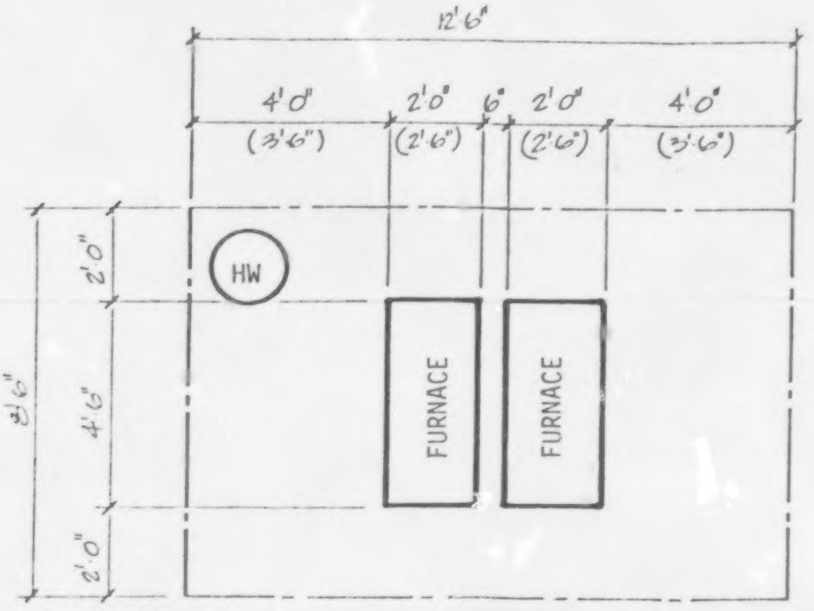
1. Heating load assumed to be 150,000 BTU/HR.
2. A simple "pot-type" oil-burning stove should be installed, centrally located to heat entire building under emergency conditions.
3. Hot Water Heater: Electric, 2 KW.



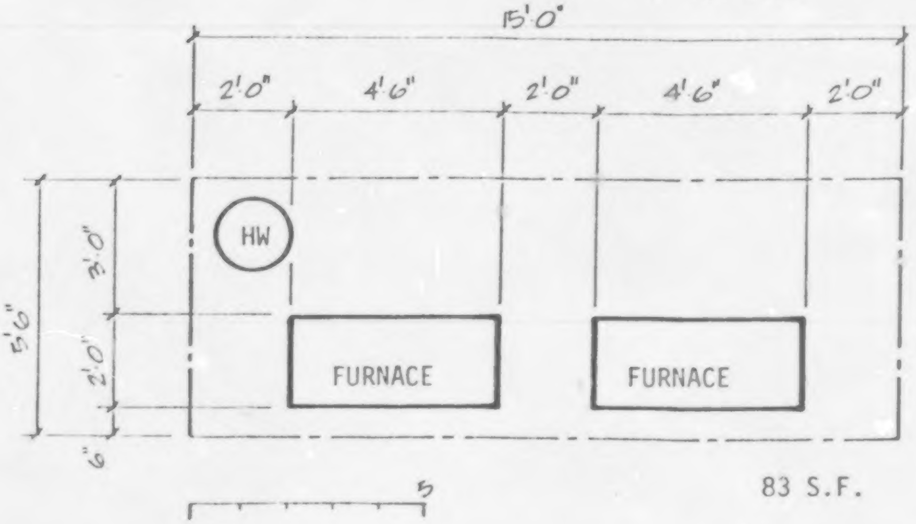
51 S.F.

(1) Furnace (No Standby):

BTU Each Furnace:	150,000
Furnace Dimensions:	30" x 40"
Furnace Room Dimensions:	6'-0 x 8'-6'


12'6"
4'0"
2'0"
6"
2'0"
4'0"
(3'6")
(2'6")
(2'6")
(3'6")
8'6"
2'0"
4'6"
2'0"
HW
FURNACE
FURNACE

100 S.F.


15'0"
2'0"
4'6"
2'0"
4'6"
2'0"
5'6"
3'0"
2'0"
6"
HW
FURNACE
FURNACE
5

83 S.F.

(2) Furnace (75% of Full Load Each):

BTU Each Furnace: 95,000
Furnace Dimensions: 24" x 54"
Furnace Room Dimensions: 8'-6" x 12'-6"

SUPPLEMENTARY SPACE

10. MAINTENANCE ROOM

The maintenance room is provided within the small rural high school as a space for building repair, daily cleaning, and storage. It is required by building code that this space not be part of the fuel-fired equipment room. The workbench and storage shelving should be carefully planned and built-in to prevent this space from being used for unauthorized purposes. This room must be large enough to house all cleaning equipment (vacuum, mops, ladder, cart, brooms, etc.), a minimum quantity of cleaning supplies and products, a mop sink, a workbench (30" x 60"), and storage for tools, manuals, maintenance records, and spare parts. This space must be well lighted, accessible, and adequately sized to meet the needs of the local maintenance program requirements. Usually the maintenance room will be located on a plumbing wall adjacent to the toilet areas to minimize plumbing runs.

PHYSICAL CHARACTERISTICS

Size: 76 square feet minimum.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Construction; see UBC, Section 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: General 30 FC, and 70 FC task lighting over workbench.
2. Power: Three outlets; ground fault protected (one at workbench height).

Mechanical:

1. Plumbing: (Site-specific).

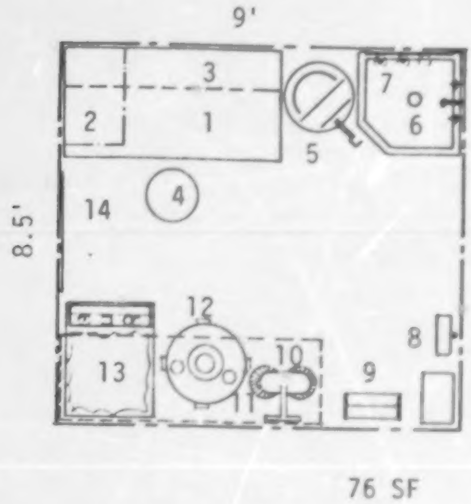
PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Maintenance:

Item No.	Equipment List
a.	Mop sink
b.	Mop rack
c.	Shelving (above and below workbench)
d.	Vacuum cleaner, hose, and attachments
e.	Janitorial cart (optional)
f.	Ladder
g.	Miscellaneous cleaning supplies (gallon containers)
h.	Miscellaneous paper products (2 week's supply)
i.	Building maintenance tools
j.	Large push broom
k.	Large push dustmop
l.	Snow shovel, ice chipping tool
m.	Wet mops
n.	Mop bucket with wheels and wringer
o.	Vise
p.	Tool box
q.	2-drawer file cabinet

Special Requirements:

1. Workbench with metal surface.



1. WORK BENCH W/METAL SURFACE
2. 2 DRAWER FILE CABINET
3. TOOL & PARTS STORAGE
4. STOOL
5. MOP BUCKET
6. MOP SINK
7. MOP & BROOM RACKS
8. SHOVEL & MISCELLANEOUS BUILDING MAINTENNANCE TOOLS
9. STEP LADDER
10. FLOOR CLEANER
11. PAPER & CLEANING SUPPLY STORAGE
12. VACUUM CLEANER
13. JANITORIAL CART
14. PORTABLE SCAFFOLD

SUPPLEMENTARY SPACE — 11. CIRCULATION

The defined circulation space in the facility for 11-20 students will vary according to whether the design is an open or traditional plan. In an open-plan concept, actual circulation space exists, but is calculated as a part of the assignable classroom area. Efficiency calculations of assignable and unassignable space may be misleading. In either case, circulation paths should avoid dissecting a program area, and should instead be used to emphasize teaching stations and minimize disruptions. The corridor may be used as an acoustic buffer between quiet and noise producing areas, e.g., between multipurpose and academic areas, but may also act as a conductor of unwanted sound from noisy to quiet spaces. The corridor may also be utilized as a distribution spine for utilities, i.e., plumbing overhead and waste below the floor.

The minimizing of the total space devoted to circulation should be a design goal. In determining the widths of exit corridors, the design should include an occupant load based upon use of the multipurpose room by the entire community.

The design of circulation space as an exit corridor will need to comply with the State Fire Marshal's current code interpretations if an alcove off this space is to be used for storage of students' coats and books. 1/ Handicap maneuverability, clearance, and surface finish requirements must be taken into consideration when designing circulation paths.

PHYSICAL CHARACTERISTICS

Width: Exit Corridors - 6 feet minimum.

Ceiling Height: 8 feet minimum recommended.

Material: (Quality). Exit Corridors - see UBC, Section 3304(g).

1. Walls: Durable; readily cleanable; moderate light reflectance.
2. Floors: Acoustic; color should mask effects of soiling. (At Entries: absorptive and/or readily cleanable and water resistant surfaces).
3. Ceiling: Durable acoustic.

Windows: Desirable to provide psychological relief.

1/ Taken from Minutes of Meeting on 6/30/78 with State Fire Marshal. Subject to reinterpretation by State Fire Marshal's office; reader to confirm details.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: Variable 20-30 FC, general area. Increased lighting in display and planting areas.
2. Power: Miscellaneous outlets.

Mechanical:

1. Heating: 70 degrees F.
2. Drinking Fountain: Where applicable (per handicap requirements).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Student coat and book storage
b.	Display cabinets (optional)
c.	Seating (optional)
d.	Tack surfaces

SUPPLEMENTARY SPACE 12. GENERAL STORAGE

Adequate storage specifications will be site-specific. Each particular school district must develop specifications according to its purchasing-stocking-shipping requirements and the specific logistics of each site. One option for cold storage is to provide a more cheaply constructed, separate, unheated storage building on the school site. Often, existing structures can be cheaply modified for storage use. A creative custodian and school staff can maximize storage space if unneeded items are disposed of and material inventories are carefully monitored (one small school was found annually ordering envelopes without realizing they had an 80 year supply). Suggestions that help assure that the storage room is used as programmed include shelving installed at construction, a minimum of circulation space, minimum electrical outlets, and utilization of odd shaped "left-over" areas. Long-term storage can be provided in attics and mezzanines when provided with access that is convenient and heavy enough for carrying the supplies to the space; however, all storage rooms must be One-hour Fire-resistive Construction. If the storage room is located on the second level, the State Fire Marshal is currently classifying the facility as a 2-story structure due to the potential of the storage room being used as a classroom. (See Section 5.40).

Three separate storage areas are needed for each school to provide for:

1. Plant Support Materials: Toilet paper, extra pipe, spare parts, cleaning supplies, oil, etc.
2. General Instructional Supplies: Books, paper, audio-visual equipment, etc.
3. Food Storage: (Food must be stored on shelves or pallets above the floor, and food must not be stored in classrooms or the boiler room).

PHYSICAL CHARACTERISTICS

Size: (site-specific).

1. Plant Support Materials: 80 square feet (8' x 10').
2. General Instructional Supplies: 80 square feet (8' x 10').
3. Food Storage: 84 square feet (6' x 14'); Class "A" lunch program.

Ceiling Height: Varies (if less than 6'-6", this can be considered "bonus" space according to DOT/PF Design Standards for Space Utilization).

Materials: One-hour Fire-resistive Construction Per UBC 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Varies (use minimum required).

Mechanical:

1. Heated or Unheated: Varies (site-specific).
    a. Plant Support Materials: Above 32 degrees F.
    b. Food Storage: Cold - 0 degrees F.; Dry Goods - 60 degrees F. or below.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Industrial grade adjustable shelving w/12" wide shelves.

SUPPLEMENTARY SPACE — 13. FOOD SERVICE

The food service program for a secondary school of 11-20 students will depend on several factors:

1. Local village priority for food service program versus other programs.
2. Ability of secondary school to share use of food service program at elementary school, or in the other instance, the need to provide for a combined food service program as a part of the secondary school.
3. Type and extent of food service program to be offered by the school district.

The food service program is a major operational expenditure. To reduce operating costs, some districts are switching their program from the traditional hot lunch to a program where frozen dinners are heated in convection ovens and served to the students with disposable dishes and utensils. This not only cuts down on the cost per meal, but also reduces the need for an elaborate kitchen, minimizes staffing, and allows more space and budget to be devoted to operating the educational program. In some villages, this frozen dinner program may not be popular if it causes a reduction in local employment.

The frozen dinner program does not need a separate kitchen and may utilize home science equipment provided in the lab area. However, if the food service program is to be included as a part of the lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. If proper sanitizing for dishwashing is unavailable, disposable dishes and utensils must be used for the food service program as well as for home science. If the lab is utilized for this type of food service program, additional space must be provided for the storage of dry goods, frozen goods, and paper products, depending on frequency of delivery. It may also be desirable to specify a commercial convection oven.

Government subsidies are available to districts to help defray the cost of the food service program as long as the program complies with Federal standards. Subsidies, local employment, and demand may keep the traditional hot lunch program as a feasible program in many districts; in this case, additional space must be programmed into a facility to accommodate food preparation and dry and cold storage.

PHYSICAL CHARACTERISTICS

Size: 336 s.f. minimum.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable.
3. Ceiling: Washable.
4. Base: Coved, washable.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC general area; 70 FC task lighting; vapor-tight fixtures.
2. Power: 120/208-V., 3-phase; load varies with equipment.

Mechanical:

1. Heating: 65 degrees F.
2. Ventilation: Use range hood; draw make-up air from adjacent areas.
3. Plumbing:
   - a. Waste: Sink requires grease trap which presents problems with or without this unit.
   - b. Water: Hot and cold. Sanitizing water (140 degrees F.) required if washing dishes or utensils.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

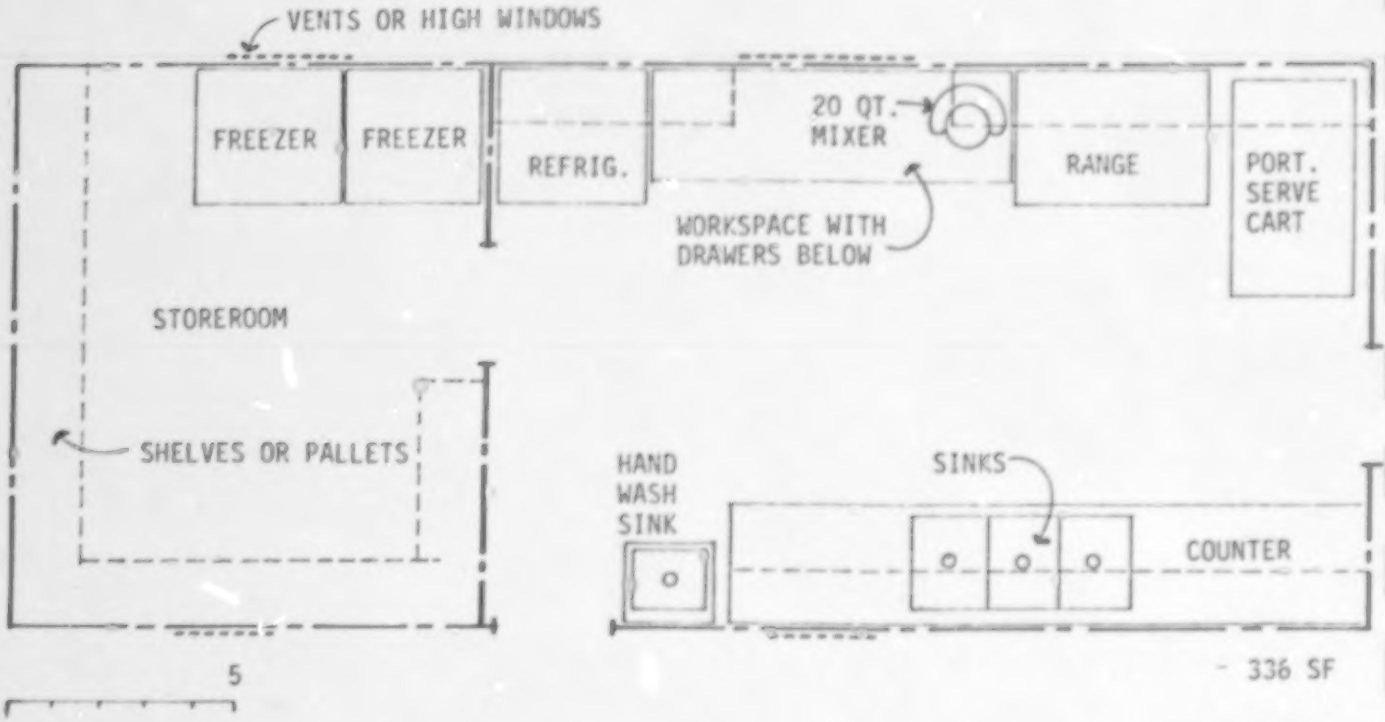
Frozen Dinner Program:

Item No.	Equipment List
a.	Convection oven
b.	Sink
c.	Disposable dishes and utensil storage
d.	Dry goods storage
e.	Frozen goods storage
f.	Refrigerator
g.	Exhaust hood

Traditional Hot Lunch:

Item No.	Equipment List
a.	Range with oven, 36" (1)
b.	Oven, convection (1)
c.	Stock pots (varies)
d.	Mixer with attachments (1-20 qt.)
e.	Dishwasher or 3-compartment sink with drainboard
f.	Handwash sink
g.	Refrigerator
h.	Freezer
i.	Cook's table with drawers and rack
j.	Pot and pan storage rack
k.	Exhaust hood
l.	Utility cart, 3- shelf
m.	Fire extinguisher
n.	Microwave oven
o.	Student seating tables and storage

CONCEPTUAL LAYOUT FOOD SERVICE


VENTS OR HIGH WINDOWS
FREEZER
FREEZER
REFRIG.
20 QT. MIXER
RANGE
PORT. SERVE CART
WORKSPACE WITH DRAWERS BELOW
STOREROOM
SHELVES OR PALLETS
HAND WASH SINK
SINKS
COUNTER
- 336 SF
5

Plan developed by Amelia E. Snell, R.D.
Furnished by DOE

KITCHEN - SERVING UNDER 25 STUDENTS

SUPPLEMENTARY SPACE

14. ON-SITE GENERATION

Some level of on-site electrical generation will be required at nearly every site. Size, type, and number of generating units will vary according to the size of the school and availability, reliability, and cost of commercial power (see discussion in Section 9.42, Building Utilities). Levels of on-site generation will be divided into three general categories:

> Level One; Minimum Standby: On-site generation of minimum capacity required to keep essential systems operating to prevent damage to the school during commercial power outages. Unit is sized to power a few lights and building heating equipment. Use of the school would not be possible while on standby power. This level of on-site generation would be applicable to those sites having reasonably reliable commercial power systems where power outages would be expected to occur infrequently and be of short duration.
>
> Level Two; Full Standby: On-site generation with sufficient capacity to allow normal operation of the school during loss of commercial power. Standby generation would be provided by a single unit sized to accommodate the full load requirement of the school. This level of on-site generation would apply where outages of several days' duration can be expected.
>
> Level Three; 100% On-Site Generation: On-site generation to provide 100 percent of the school's electrical energy would consist of two generating units sized to accommodato the school's full load requirements, plus one smaller generating unit for night and weekend loads. This level of on-site generation would apply where commercial power is unavailable, too unreliable, or too costly to be used.

Space requirements for any level of on-site generation must allow easy access to both sides and rear (generator end) of each generating unit for maintenance and repair. Space must also be provided for proper clearance in front of switchgear, and for working clearance around any auxiliary equipment. For Level Three generation, workbench space should be provided, in addition to the workbench space provided in the school maintenance room.

Space for Level One generation might be provided within the school building itself. As an alternative, Level One generation could be provided by a portable, air-cooled, fully enclosed unit which is moved from storage into place outside the school and plugged into an exterior connection when needed.

Level Two and Three generation should be installed in a building separated from the school and all other buildings by at least 20 feet for fire and noise reasons.

PHYSICAL CHARACTERISTICS

Size: Varies with level of on-site generation and physical size of generating units:

Level One: 90 square feet.
Level Two: 120 square feet.
Level Three: 264 square feet.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Table 5-B.

1. Walls: Taped gypsum board.
2. Ceiling: Taped gypsum board.
3. Floor: Nonabsorptive; nonslip (metal with abrasive finish; light weight concrete).

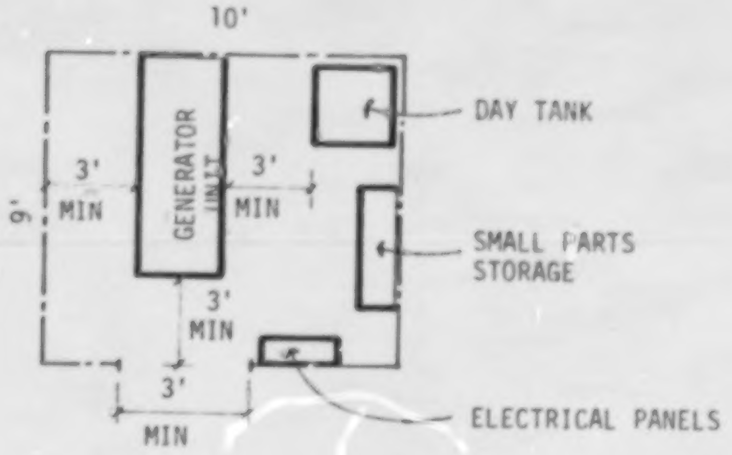
SERVICE REQUIREMENTS

Electrical:

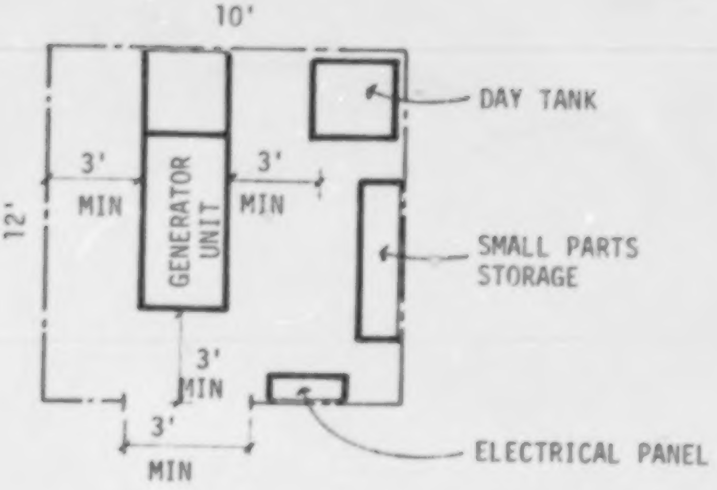
1. Power: Convenience outlets located around perimeter of generator building, approximately 10 feet on center. Convenience outlets over workbench. Power for jacket water tank heater.
2. Lighting: 20-30 FC, general lighting; 70 FC task lighting over workbench.

Mechanical:

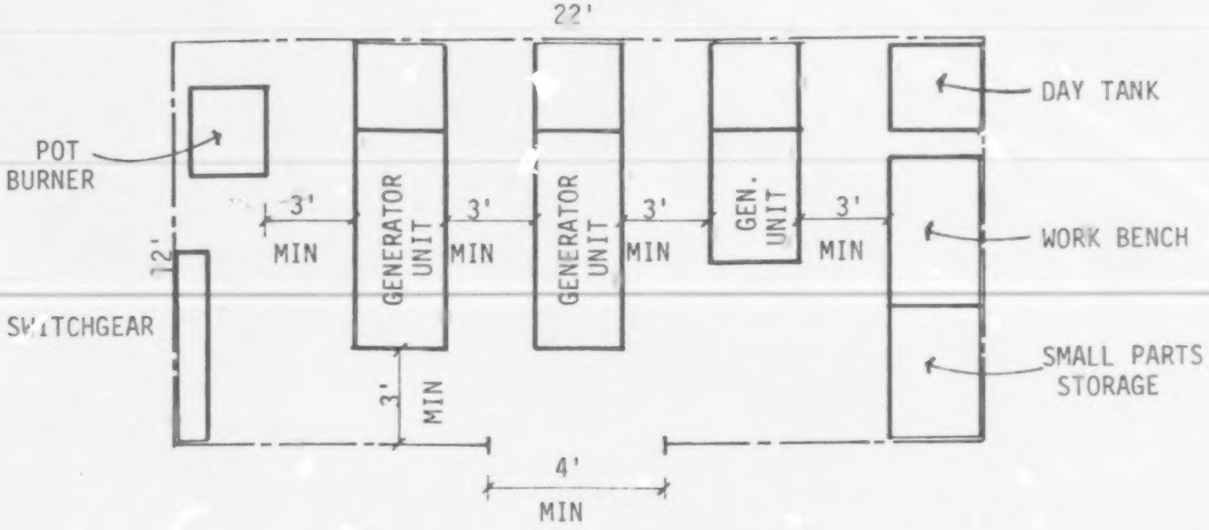
1. Fuel supply.
2. Cooling air for generator and jacket water, combustion air for engine.
3. Waste heat equipment (Level Three).
4. Fire Suppression: Halon or CO2 system.


10'
9'
GENERATOR UNIT
3' MIN
3' MIN
3' MIN
3' MIN
DAY TANK
SMALL PARTS STORAGE
ELECTRICAL PANELS

LEVEL ONE


10'
12'
GENERATOR UNIT
3' MIN
3' MIN
3' MIN
3' MIN
DAY TANK
SMALL PARTS STORAGE
ELECTRICAL PANEL

LEVEL TWO


22'
POT BURNER
12'
SWITCHGEAR
3' MIN
GENERATOR UNIT
3' MIN
GENERATOR UNIT
3' MIN
GEN. UNIT
3' MIN
3' MIN
4' MIN
DAY TANK
WORK BENCH
SMALL PARTS STORAGE

LEVEL THREE

SUPPLEMENTARY SPACE

15. WATER UTILITY

For those villages with central piped distribution systems, space allocation for water service should take no floor space unless a small recirculation pump is required. In the case of the latter, provision for access to the pump for periodic maintenance should be provided. (See Section 6.1 for water system options, and Section 3.1 for water system determinants).

For newly developed school sources, space allocation for water utility pressurization, treatment, and pumping will be necessary. The location of a water utility area should be on the main floor and easily accessible. Daily monitoring of treatment is necessary. If located on an upper level, access shall be by a full-sized stairway. Space set aside for storage of chemicals and replacement/repair of mechanical equipment should be analyzed by the architect. Many villages have annual delivery service only by barge, and high air freight delivery costs should be compared to the initial cost of providing annual storage space for items needed to maintain the water utility.

Protection from freezing is mandatory. Failure of the water system may not stop operation of the teaching program, but will result in loss of capital investment as well as providing a hardship. The occurrence of communicable disease is high in those villages without a central system; often, the villagers look to the school as the only safe potable water supply.

Design of the system for a maximum six-year projected enrollment will allow for reasonable future expansion. A minimum of 25 gallons per person per day is a recommended minimum where water sources availability permits.

Use of storage tanks as a wintertime supply will require additional space for heating for equipment that provides freeze protection. Sizing of the tank should be based on the longest expected freezing time of the source, with an additional buffer for concentration of contaminants at the bottom of the tank.

Connection of the water supply to the building should take the differential movement of each into consideration. Use of insulated flexible connections is recommended.

PHYSICAL CHARACTERISTICS

Size: Varies with equipment used; minimum 30 square feet.

Ceiling Height: 7.5 feet minimum.

Materials:

1. Walls: High light reflectance, washable. Chemical resistance in storage areas.
2. Ceiling: High light reflectance, washable.
3. Floors: Impermeable, noncombustible depending on heating equipment used for equipment room or storage tanks.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Heating: Above freezing.
2. Plumbing (site-specific).
3. Supplementary fuel supply.
4. Chlorination system.
5. Cartridge filtration system.

SUPPLEMENTARY SPACE 16. WASTE WATER DISPOSAL

Connection of the building sewer line to an existing sewer system should take no additional space when a gravity sewer service line is used. If a pump is necessary to move the sewage into the existing utility, then a sump may be required at some point in the building, probably below floor elevation. Sump pumps may also be required for moving sewage to a treatment plant or septic tank. Sumps could be located with easy and complete access through the floor from "supplemental" space above. The enclosure for sumps must be very well insulated with nonmoisture susceptible insulation; additional heat may be needed here, as it is at a low elevation within the building.

Septic tanks are usually installed outside the building and underground; thus, they would require no space within the building. Other similar alternatives such as a lagoon or pond disposal would require no building space other than a possible sump pump as stated above.

Nonwater-borne waste disposal, as found in chemical, humus, or incinerating toilets, may need additional space to allow proper handling of wastes such as holding tanks and "honey buckets". Special access to such toilets may be desirable from an esthetic point of view. Methods of collecting such waste may dictate location in the building.

When a sewage treatment plant within the building is deemed the best solution, additional storage space will be required for chemicals used in treatment. The frequency of delivery of such chemicals will dictate the amount of storage required.

Capacity for future expansion can be adequately handled by designing for a projected enrollment as discussed in Section 6.2. The size of the treatment plant listed below is based on 15 gallons per capita per day for schools without multipurpose rooms and showers, and 25 gallons per capita per day for schools with multipurpose rooms and showers.

PHYSICAL CHARACTERISTICS

Size: Home-sized treatment plant, up to 1,000 gpd. 7' x 7' for equipment with clearance for maintenance; 100 square feet total.

Ceiling Height: Depends on type of unit. If pumps must be lifted above tanks for maintenance and repair, ceiling height may need to be as much as 14 feet.

Materials:

1. Walls: Good light reflectance, washable, chemical resistant.
2. Ceilings: Same as walls.
3. Floors: Impermeable, sloped to drain with emergency overflow provisions.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: To handle up to two HP., two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Temperature: Above freezing.
2. Plumbing: To handle flows.
3. Heating: Separate from rest of building.
4. Ventilation: Separate from rest of building.
5. Chlorination: Usually in tablet form; no power required.

General: Space requirements for packaged sewage treatment plants will vary with models available. Sizes are not standardized. Different methods of treatment would dictate size also. "Batch" treatment requires waste water storage at beginning of process, which may increase the space requirement. Sizes of packaged treatment plants are usually supplied in increment sizes that would accommodate more than one size of school.

DOE SECONDARY SCHOOLS SPACE GUIDELINES

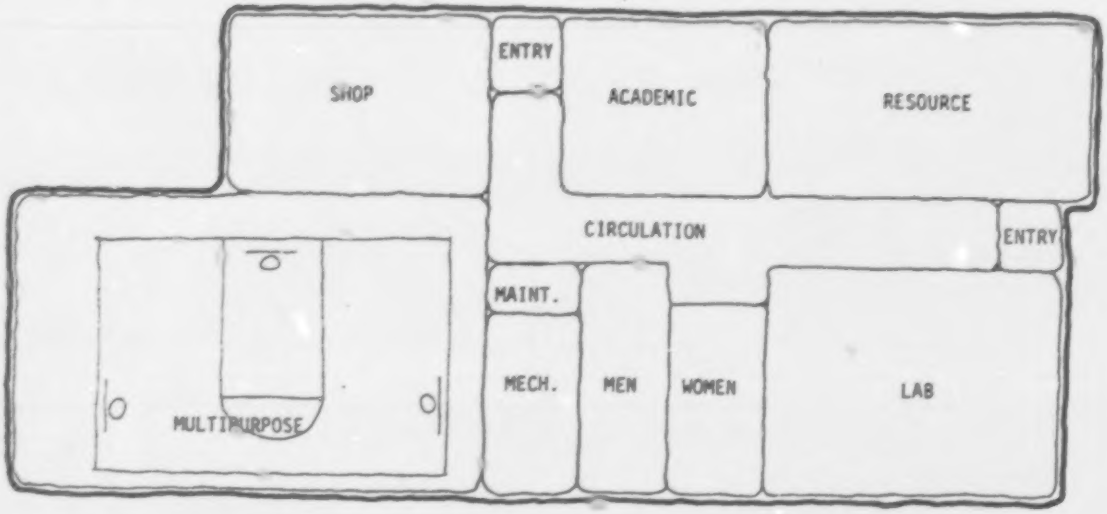
Student Enrollment	10-20
Classroom(s)	800 1/
Library/Media Center (% of Individual Study Space)	900 75%
Science Classroom	-0-
Office	-0-
Business Education	-0-
Home Science	-0-
Industrial Education	400
Multipurpose Space	1,200
Supplementary Space	1,155 (26% of Gross)
Restrooms Storage Hallways Wall Thickness Kitchens Mechanical Space	
TOTAL	4,455 S.F.

1/ Includes wet area for Science/Home Economics.

The secondary school for 21-32 students will be a total facility of approximately 6,480 square feet, of which 4,800 square feet will be designed for various high school programs and approximately 1,680 square feet will be needed for supplementary space, e.g., toilets, maintenance room, mechanical room, and general storage.

A school of this size will be staffed by two or three teachers, depending, of course, on school district policy and availability of funds. For planning purposes, allow space for three. Besides functioning as a teacher, one staff member will also function as the principal and assume responsibility for total operation of the school program and facility.

Program requirements, activities, and space requirements will influence the division of assignable space into program areas. Three basic concepts of organizing program spaces are illustrated in the following figures.



TRADITIONAL PLAN

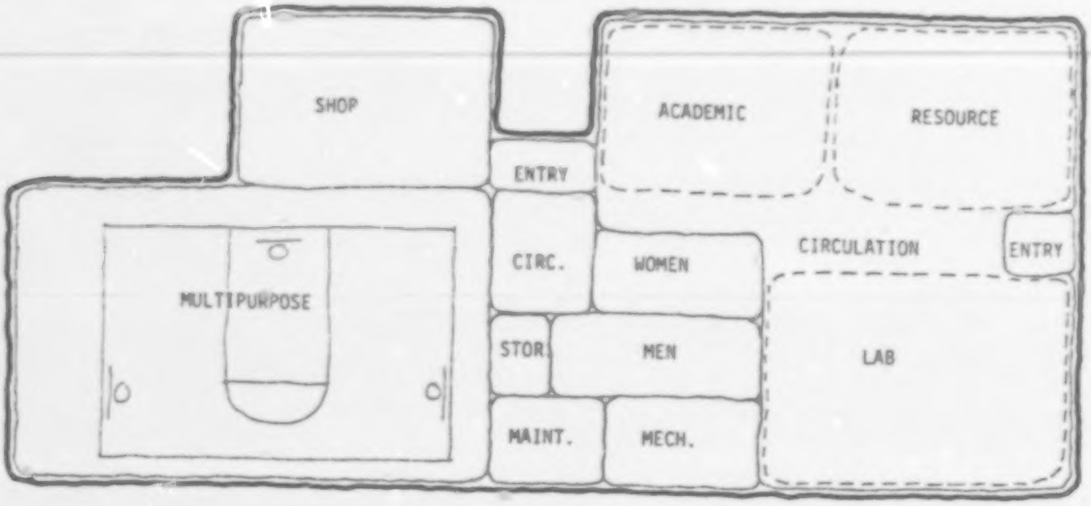
The traditional plan illustrated above is a classic example of organizing educational and supplementary space. This concept is characterized by the use of fixed classrooms and corridors.

1. Advantages:

   a. Generally preferred by teachers.
   b. Minimizes both visual and acoustical distractions.

2. Disadvantages:

   a. Lack of flexibility for changes in enrollment and program.
   b. Limits teacher's supervision ability to one area.
   c. Total plan will have a higher percentage of unassignable space due to having defined corridors.
   d. First cost of building partitions versus open space will be higher.



OPEN PLAN

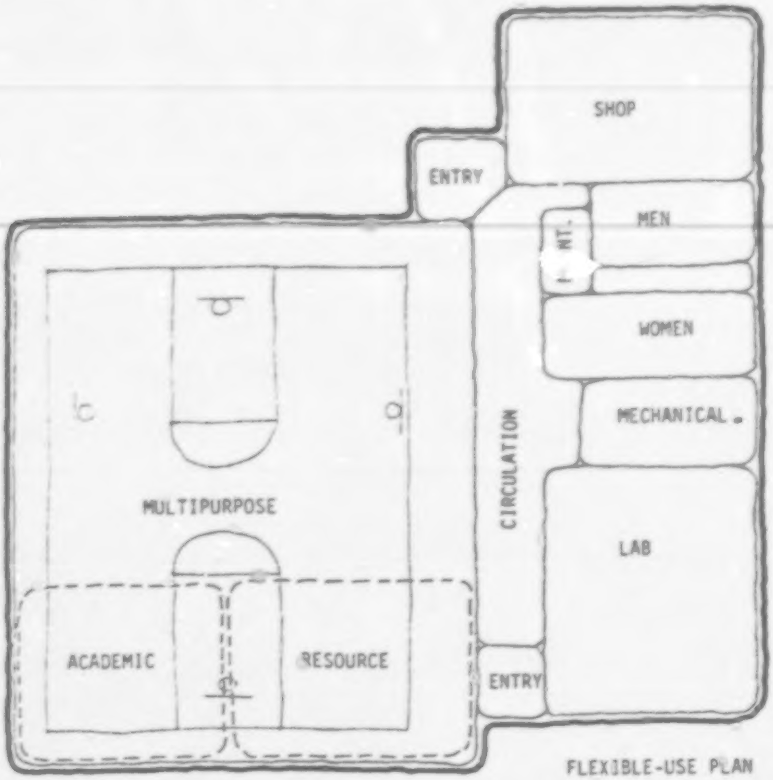
The open-plan concept combines all of the teaching areas into one "open" space and uses movable partitions and furniture to define program areas.

1. Advantages:

   a. Allows for greater flexibility in program and enrollment.
   b. Reduces first cost of construction.
   c. Will give a higher percentage of assignable space because the circulation space is included in the classroom area. The plan will appear more efficient.
   d. Allows for a teacher to supervise more than one area at the same time.
   e. Easier to make service modifications, i.e., mechanical/electrical.

2. Disadvantages:

   a. Acoustic and visual distractions can be potential problems. The open-plan will require well-coordinated program space planning, interior design, and acoustical engineering to produce good academic areas.


SHOP
ENTRY
MEN
NT.
WOMEN
MECHANICAL
CIRCULATION
MULTIPURPOSE
LAB
ACADEMIC
RESOURCE
ENTRY

FLEXIBLE-USE PLAN

A local or district desire to increase multipurpose area could be accomplished by combining academic, resource, and multipurpose spaces together, forming a flexible use plan as illustrated above. While this will increase space available for recreation, there will be a trade-off for acoustics and a traditional classroom atmosphere.

1. Advantages:

   a. This concept has the ability to maximize multipurpose space which, in many villages, will also be used by elementary students and the community.

2. Disadvantages:

   a. It is projected that the first cost of this scheme will be greater due to the need to provide expensive acoustic separation and treatment to allow for classroom activities. The increased volume would also add to the construction cost.
   b. It is uncertain how well this space will function for classroom activities. The multiuse concept may place an additional burden on teachers.

Acoustical separation of noise-producing areas, such as the shop from classroom areas, is achieved in the conceptual plans by remotely locating the two activities. Service cores and corridors can be utilized as buffers between acoustically noncompatible program areas.

In reviewing the three conceptual plans, you will note that a specific kitchen or food service area has not been indicated on these illustrations. In most villages, an elementary school with an on-going food service program will already exist. It will be determined by each school district how the food service program for the secondary school is to be handled.

Whether or not a food service program is provided as part of the secondary school, and to what extent, will have major effects on the allocation of space, sizing of mechanical systems, selection of materials, and general layout of the school plan.

The food service program, general storage, and site utilities, e.g., water, waste water, power generation, are additional program items that must be incorporated into the design as determined by specific site conditions, budget limitations, and district priorities.

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Science	Students dissecting various animals and plants; performing chemical experiments; mixing fuming chemicals; sorting, categorizing and storing various rocks, plants, animals, and sea life, and putting them in display cases; viewing films.	Lab (Project Area)
Math	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 5-15: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Language Arts	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips.	Academic Area

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Language Arts (Con't.)	Discussion: Groups of 5-15: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area (Con't.)
Social Studies	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 5-15: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Physical Education	Description of Activities: Passive: Total class or total school holding assemblies, viewing movies and/or stage plays.	Multipurpose

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Physical Education (Con't.)	Individual Skill Practice and Dual Sports: Groups of 5-32 practicing skills and participating in fitness and related physical education activities (e.g., wrestling, calisthenics, gymnastics, archery, table tennis, shuffleboard, four-square, weight training, etc.). Team Skills: Groups of 5-20 practicing skills and participating in team activities (e.g., basketball, floor hockey, volleyball, flag football, soccer, softball, etc.). Community Use: Passive: Total community viewing of movies, watching plays and Christmas programs; holding community meetings; dances; festivals. Individual and Team Sports: Various groups from the community participating in fitness and related physical education activities and team sports (e.g., basketball, shuffleboard, weight training, volleyball, softball, etc.).	Multipurpose (Con't.)

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Electives:		
Home Science	Small groups of students working in the four skill areas of cooking, sewing, homemaking, and child care, as well as passively reviewing TV and films as a group, and slide and/or filmstrips; cassette tape presentations as a group or as individuals. Cooking: Frying, baking, mixing, washing dishes, measuring, cooking, freezing. Sewing: Measuring, laying out, sewing, cutting, pressing or ironing, etc. Homemaking: Interior design, entertainment, food storage, family living, cleaning, washing and drying clothes, home nursing. Child Care: Dressing, feeding, holding, entertaining, observing.	Lab (Project Area)
Business Education	Typing: Students will in general be working individually or in groups of 1-6. Students will learn individually studying in carrels using slide-tape machine and typewriters.	Lab or Sound Module

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Business Education (Con't.)	Office Practice: Students will learn and work individually with various office machines.	Sound Module or Lab (Con't.)
Music	1) Performing: (a) Singing (b) Playing instruments, optional w/sound module. 2) Listening 3) Creating	Academic Area
Art	1) Painting 2) Drawing 3) Pottery Making 4) Carving 5) Printmaking 6) Constructing 7) Forming 8) Weaving 9) Etching.	Lab (Project Area)
Trade & Industries	Assembling, disassembling small engines; measuring, sawing, fitting, gluing, nailing, sanding, building, blueprint reading, drafting; welding/metals optional.	Shop
Library/Media	The focus of the academic area is envisioned to be the learning resource center. It is the depository for teaching resources and a space for individual learning. It should be readily accessible to individuals and groups and	Resource Area w/Carrels

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Library/Media (Con't.)	should be closely related to specialized learning laboratories. One of the major components in the learning resource center which can bridge both learning and social differences between remote areas and the outside world is the audio-visual information center. Here a well-supplied source of learning materials can bring the world of today into the classroom for all students.	Resource Area w/Carrels (Con't.)
Auxiliary Services:		
Administration	Counseling students individually or in small groups; greeting and/or talking to parents and other groups; filing reports, permanent records, typing reports, conducting phone and radio communications, duplicating of teaching material, and testing.	Teacher Office Area/Administration
Food Service	Extent of activity to be determined by school district and availability of other existing facilities.	Lab or Food Service Area; Storage - Cold and Dry

1. ACADEMIC AREA

The academic area should provide for conventional educational experiences but should be flexible enough to accommodate changes in enrollment, learning-group sizes, activity requirements, and teaching methods. The academic area should provide for instruction in the following program areas: math, social studies, language arts, music, and other electives.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Material: (Quality)

1. Walls: High light reflectance.
2. Floors: Acoustic; color should resist effects of soiling.
3. Ceiling: Acoustic.

Windows: Windows are desirable to provide psychological relief, back-up ventilation, and emergency exits, but their use must be limited to minimize heat loss and potential distraction.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at desks and chalkboard.
2. Power: Two outlets or power poles on each wall.
3. TV jack.
4. Clock (battery).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Math:

Item No.	Equipment List
a.	Chalk and tackboards
b.	Student seating (1-21); desks or tables
c.	Overhead projector
[illegible]	Tape recorder with headsets
e.	Math lab supplies kit
f.	Calculators (hand)
g.	Projection screen (wall or ceiling mounted)

Special Requirements:

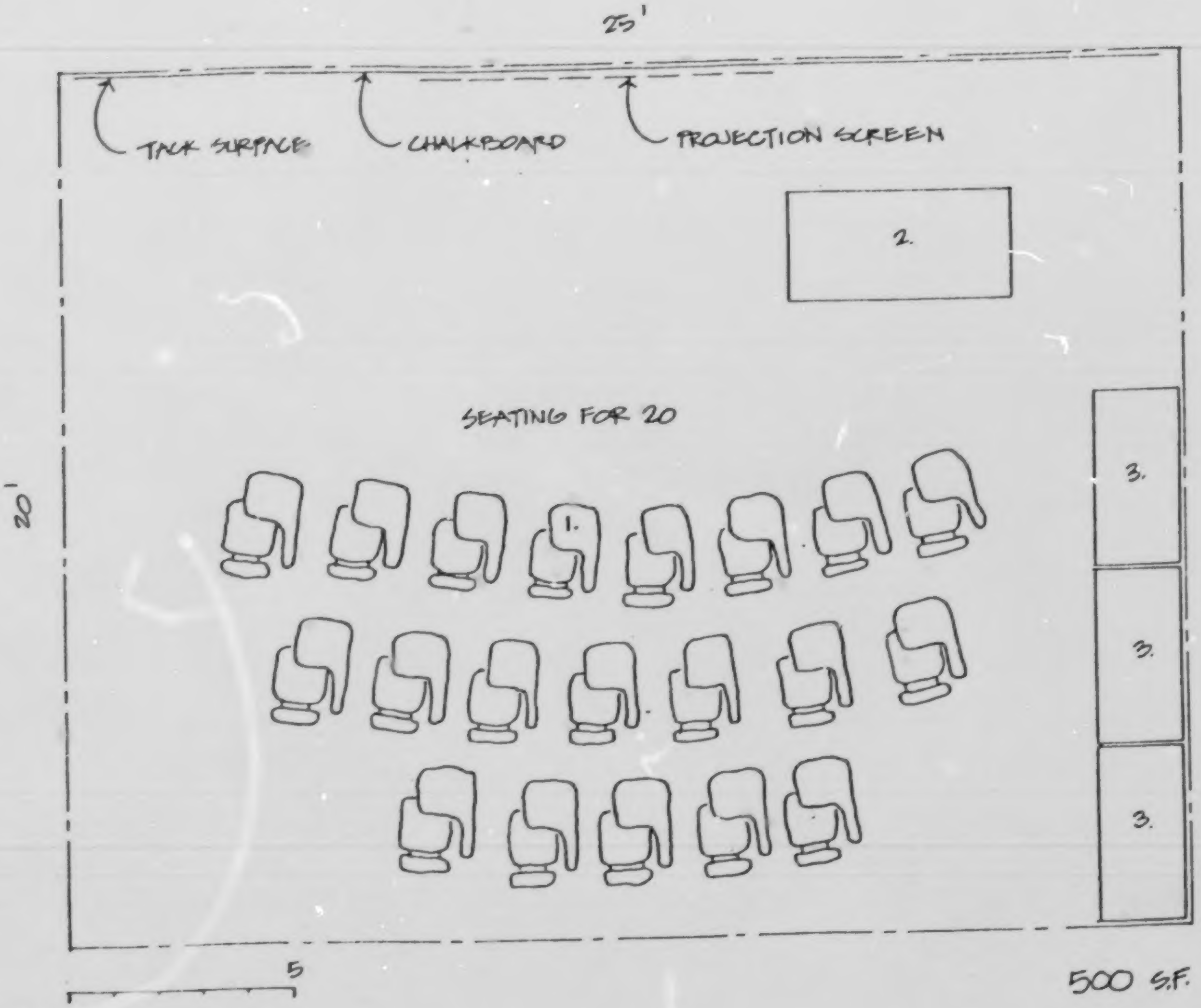
1. Power strip.
2. Project storage space (tote trays).
3. TV jack.

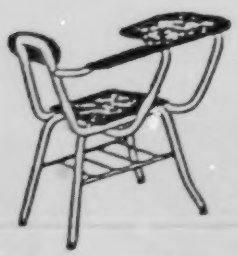
Language Arts:

Item No.	Equipment List
a.	Same as Math (not including calculators)

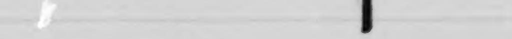
Social Studies:

Item No.	Equipment List
a.	Same as Math and Language Arts

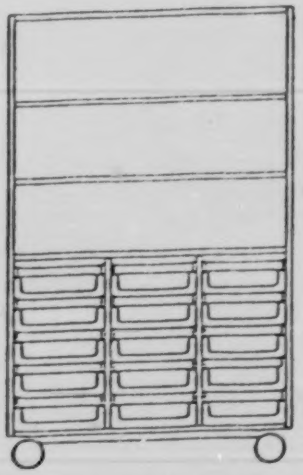

25'
TACK SURFACE
CHALKBOARD
PROJECTION SCREEN
2.
SEATING FOR 20
1.
3.
3.
3.
20'
5
500 S.F.



1. STUDENT DESK



2. DESK OR TABLE



3. MOBILE SHELVES & TOTE TRAYS, AVAILABLE WITH DOORS

2. LAB (PROJECT AREA)

The lab (project area) for the 21-32 enrollment group should be designed to accommodate science, home science, and art programs. This area might also be used by a food service program (if one exists). However, if the food service program is to be included as a part of the lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. A separate food service area might be provided, but this will decrease available space for other programs. Ideally, the secondary school might share usage of an existing food service facility in a nearby elementary school, with additional equipment and storage to be provided. The business education program might also use the lab area for a teaching center. Tables may be used in common with other programs; additional storage for business equipment would have to be provided. This facility should allow for ease in adaptation from one program to another. Careful planning for storage of all equipment and student projects for each activity, along with the specification of multiuse counter areas and furniture, will be necessary to achieve a functional design.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: (Quality). One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable (e.g., V.A.T.).
3. Ceiling: Washable finish.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at counter and table tops.
2. Power:
   a. Plugstrip around walls above countertop.
   b. 120/208-V., 3-phase.
   c. TV jack.

Mechanical:

1. Ventilation: Noxious fume exhaust; rangehood exhaust.

2. Plumbing:
   a. Hot and cold water.
   b. Acid-resistant waste pipes (Science).
   c. Plaster trap in sink (Art).
   d. Gas for Bunsen burner desired (Science).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Science:

Item No.	Equipment List
a.	Mobile student science cart (2)
b.	Science table w/acid-resistant top and 4 stools (3)
c.	Microscope (6)
d.	Plant study kit
e.	Electricity kit
f.	Simple machines kit
g.	Weather station
h.	Aquarium, 10 gallon
i.	Terrarium, 10 gallon
j.	Scale and spring balance, 15 kg. capacity (2)
k.	Rock and mineral collection
l.	Dissecting set (advanced type for 8)
m.	Hot plate - 660 W., single unit (3)
n.	Ammeter
o.	Pump (hand-air vacuum and pressure)
p.	Basic set of chemicals (provide locked storage)
q.	Assorted test tubes and flasks
r.	Assortment of science charts
s.	Project storage

Special Requirements:

1. Storage cabinet with locking doors.
2. Sink (chemical and abrasion resistant).
3. Noxious fume exhaust.
4. Bunsen burner hook-up (desired).
5. Built-in display cases (desired).
6. Electrical outlets: minimum of 4, plugstrip desired.
7. Chalk and tackboard.
8. Storage for flammable liquids.

Home Science:

Item No.	Equipment List
a.	Kitchen range, 4 burner stove
b.	Double sink
c.	Base cabinets with counter
d.	Overhead storage cabinets
e.	Assortment of small appliances (storage space to be provided)
f.	Portable sewing machine (4)
g.	Table with 4 chairs (3)
h.	Fitting mirror
i.	Dressing area (curtains)
j.	Ironing board and Storage (2)
k.	Tote drawer cabinet
l.	First aid kit
m.	Washer/dryer (optional)
n.	Assorted dishes, pots, and pans
o.	Refrigerator/freezer
p.	Microwave oven (optional)
q.	File cabinets

Special Requirements:

1. Plugstrips.
2. 140 degree hot water (desirable).
3. Chalk and tackboards.
4. TV jack.
5. Vent hood.

Art:

Item No.	Equipment List
a.	Table with 4 chairs (3)
b.	Drawing boards (8)
c.	Easel (3)
d.	Assortment of supplies
e.	Project storage
f.	Double sink with plaster trap
g.	Display space
h.	Chalk and tackboards

Food Service:

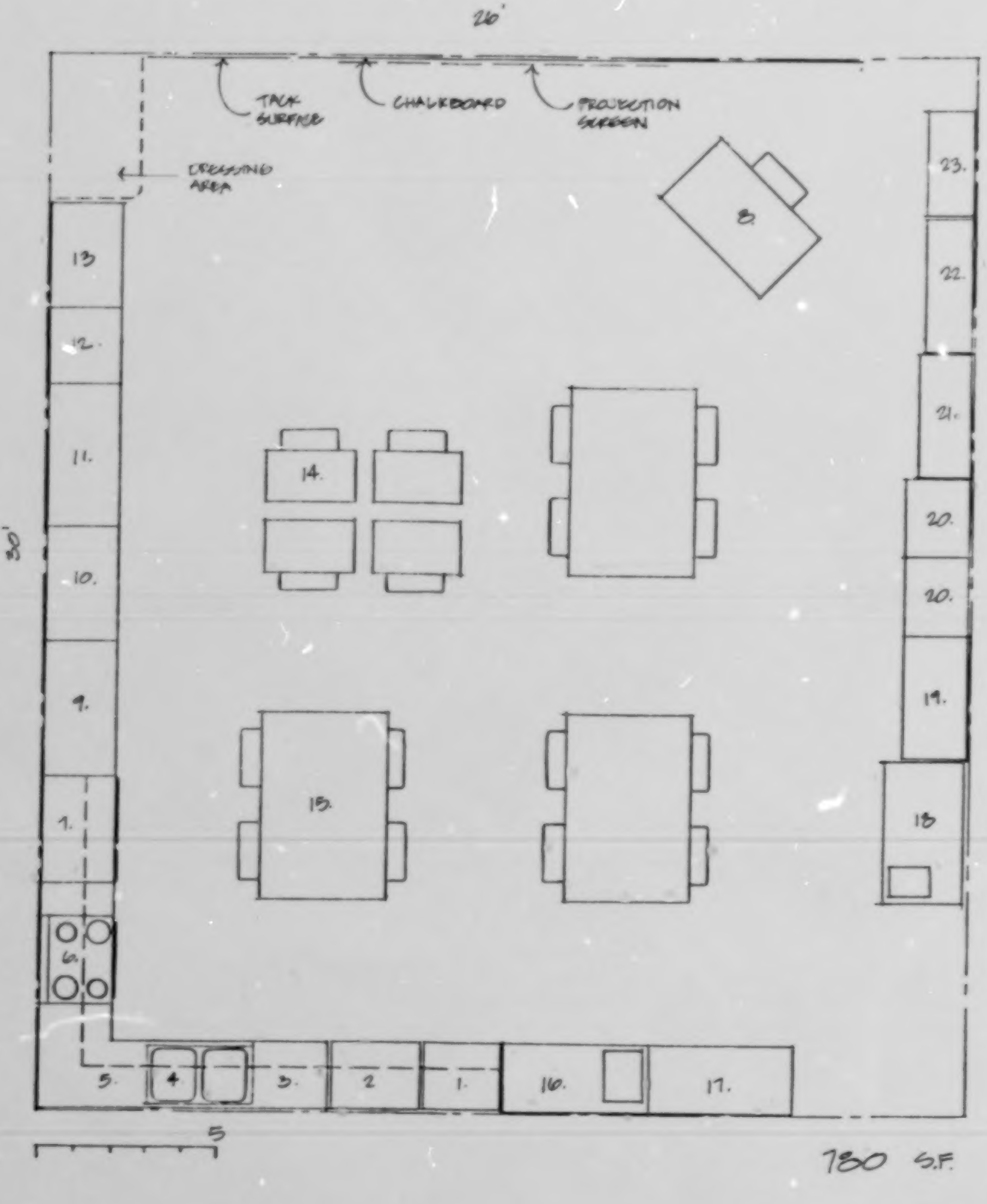
Item No.	Equipment List
a.	Stove
b.	Microwave oven
c.	Refrigerator/freezer
d.	Food, utensil, and paper storage
e.	Sink

Business Education:

Item No.	Equipment List
a.	Typewriters (2)
b.	Office machines, e.g., adding machine, printing electric calculator, duplicating machine
c.	Chalk and tackboards

Special Requirements:

1. Acoustic treatment.


26'
TACK SURFACE
CHALKBOARD
PROJECTION SCREEN
DRESSING AREA
30'
8.
13
12.
11.
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6.
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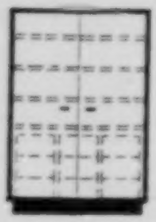
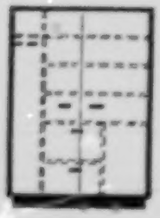
4
3.
2
1.
16.
17.
14.
15.
23.
22.
21.
20.
20.
19.
18
5
780 S.F.

HOME SCIENCE

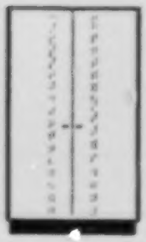
1. WASHER
2. DRYER
3. BASE CABINETS W/COUNTER
4. STAINLESS STEEL SINK
5. WALL HUNG CABINETS
6. 4 BURNER RANGE
7. REFRIGERATOR/FREEZER
8. TEACHERS DESK OR TABLE



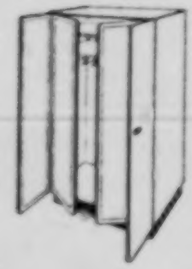
9. FOOD • STAPLES



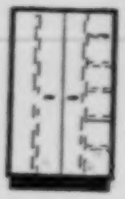
10. MISC. STORAGE



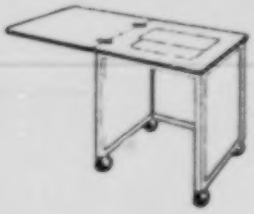
11. TOTE TRAYS (42)



12. FITTING MIRROR & WARDROBE

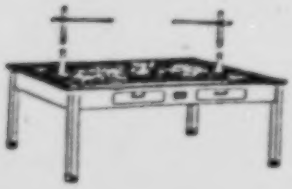


13. IRONING BOARD STORAGE

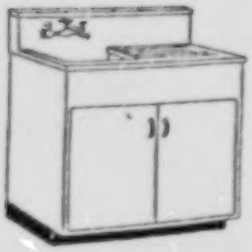


14. SEWING MACHINE TABLE

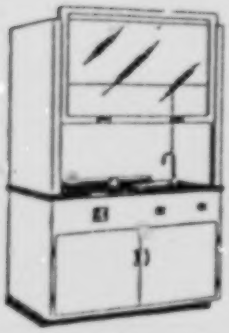
SCIENCE



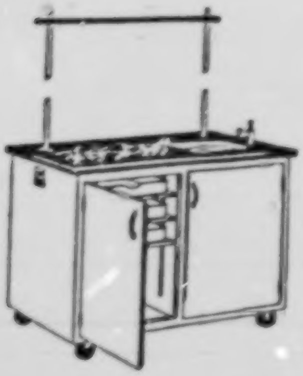
15 4-STUDENT TABLE



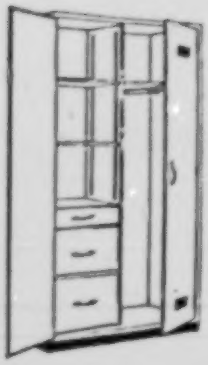
16. WALL SINK



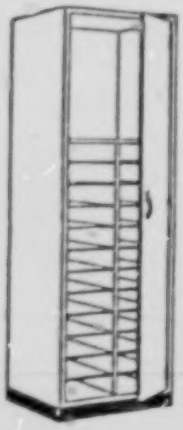
17. FUME HOOD



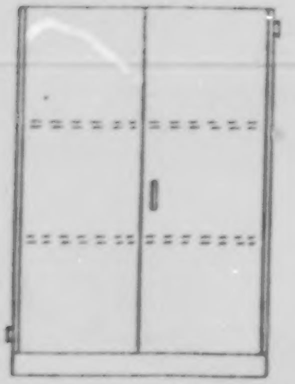
18. MOBILE INSTRUCTOR'S DESK



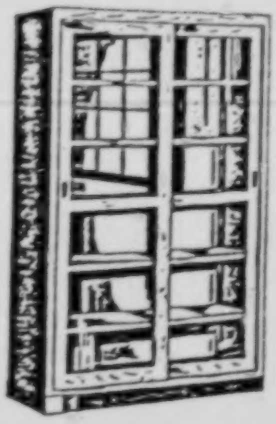
19. WARDROBE & SUPPLY



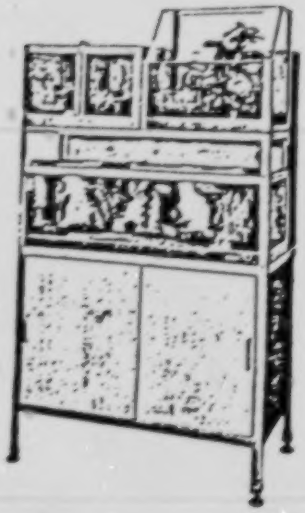
20. TOTE TRAYS



21. FLAMMABLE STORAGE



22. STORAGE & DISPLAY



23. BIO LAB

3. RESOURCE AREA

The resource area is the focal point of the educational environment in the small high school. This area will be used primarily for individualized study, but may also be used for instruction and to provide for an informal seating and meeting area. This area will be the primary depository and distribution point for educational materials and equipment, e.g., books, tapes, films, projectors, recorders, etc.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials:

1. Walls: High light reflectance; acoustic.
2. Ceiling: Acoustic.
3. Floors: Acoustic; color selection to minimize effects of soiling.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: Variable; 70 FC on desks in reading/study area.
2. Power: Plugstrip around walls and power poles in center to provide power for carrels.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Library/Media:

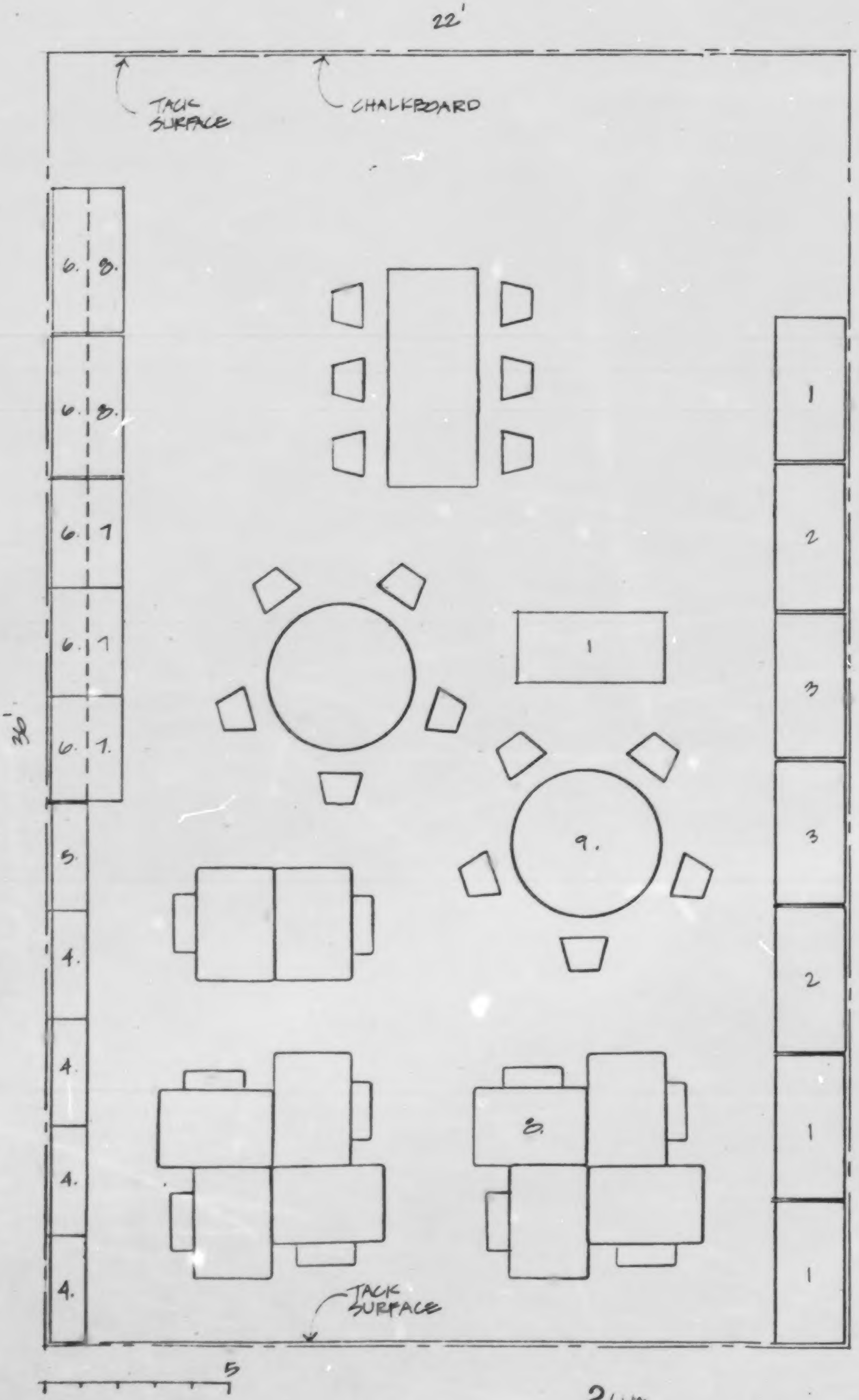
Item No.	Equipment List
a.	Seating for (21)
b.	Carrels (10)
c.	Books and periodical storage

d. A/V equipment storage:
- 16 mm. projector
- 35 mm. slide/filmstrip projector
- Overhead projector
- Microfilm viewer
- Video-tape recorder/player
- TV camera
- Cassette and video-tape storage

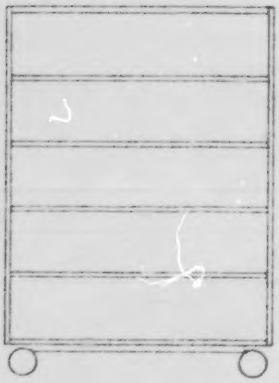
e. TV jack

Special Requirements:

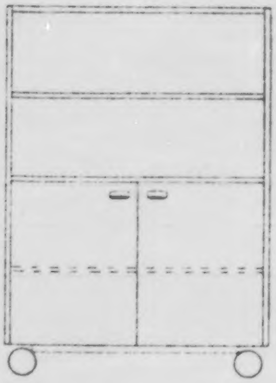
1. Power plugs or poles.
2. Task lighting.


22'
TACK SURFACE
CHALKBOARD
36'
6. 8.
6. 8.
6. 7
6. 7
6. 7.
5.
4.
4.
4.
4.
1
1
2
3
3
2
1
1
9.
8.
TACK SURFACE
5

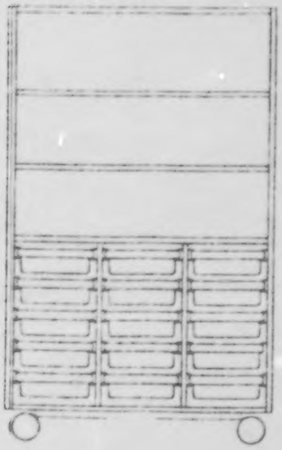
800 S.F.



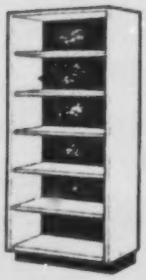
1. MOBILE BOOKSHELF



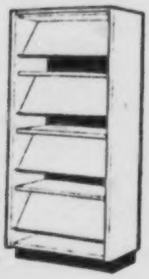
2. MOBILE BOOKSHEF & CABINET



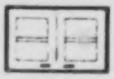
3. MOBILE BOOKSHELF & TOTE TRAYS



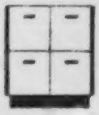
4. BOOKSHELF



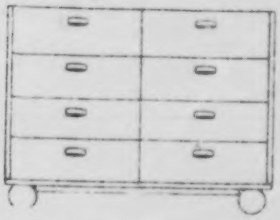
5. MAGAZINE SHELVING



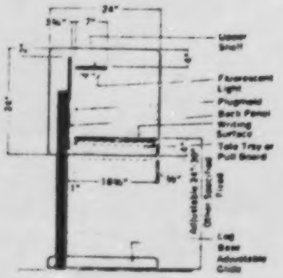
6. WALL CABINET



7. FILE CABINET



8. MOBILE DRAWERS



24"
7"
30"
Upper Shelf
Fluorescent Light
Plugmold
Back Panel
Writing Surface
Tote Tray or Pull Board
Adjustable 24"-30"
Leg Base Adjustable Glide

9 STUDY CARREL

10. TABLE & CHAIRS

4. SOUND MODULE

An expandable, movable sound module might be provided for use in coordination with business and music programs, and may also serve as a private area for study or small meetings. The use of an independent module would provide an excellent space for acoustically isolating certain activities.

PHYSICAL CHARACTERISTICS

1. As specified.

SERVICE REQUIREMENTS

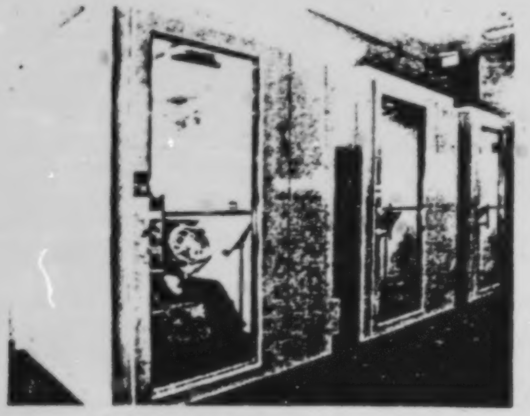
Electrical:

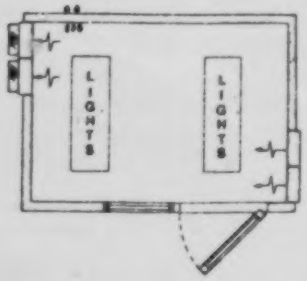
1. Power: Hook-up.

Mechanical:

1. Hook-up as specified.

CONCEPTUAL LAYOUT SOUND MODULE





5. MULTIPURPOSE ROOM

The multipurpose room should be designed to accommodate a wide range of both school and community activities that will include:

1. Physical Education
2. General Assembly
3. Theater
4. Dancing
5. General Indoor Recreation
6. Community Meetings and Events
7. Food Service (Cafeteria)
8. Spectator Activities.

To gain additional multipurpose space in the 21-32 enrollment group, space for academic, resource, and lab programs might be added to the multipurpose room and planned for flexible use. A folding acoustic wall and athletic floor carpet might be provided to allow the space to function as a classroom and multipurpose room concurrently. This arrangement will require more effort for both the students and faculty to set up, but will provide the largest recreational space allowed within the DOE guidelines.

The multipurpose room should be located in close proximity to both locker room and toilet areas. Adequate equipment storage should be provided. This storage room might be designed to be the control point for administration and distribution of equipment for after-hours use. Special consideration should be given in the design phase to adequately plan for the storage of such items as wrestling mats, volleyball standards, and gymnastic equipment. This facility may be used by students and the community after school hours; therefore, to aid in after-hours administration, the facility should be designed to allow classroom areas and equipment to be secured while the multipurpose area is in use. If the facility is to be used jointly by elementary students while class is in session, access and acoustical separation should be provided to minimize disruption of the secondary school program.

PHYSICAL CHARACTERISTICS

Size:

1. 2,000 square feet (traditional program).
2. 3,200-4,200 square feet (adding classroom area to multipurpose room and providing acoustic separation).

Ceiling Height: 20 feet minimum.

Materials:

1. Walls: High light reflectance; acoustic; flush walls desirable.
2. Ceiling: High light reflectance; acoustic.
3. Floor: Maintainable; acoustic material depends on programmed usage.

Windows: Not recommended.

SERVICE REQUIREMENTS

Electrical:

1. Lighting:
   - a. 50 FC; multilevel lighting through multiple switching.
   - b. 70 FC in areas to be used for classroom.
   - c. Guarded fixtures.
2. Power:
   - a. Battery operated clock.
   - b. Public address system.
   - c. Miscellaneous outlets.

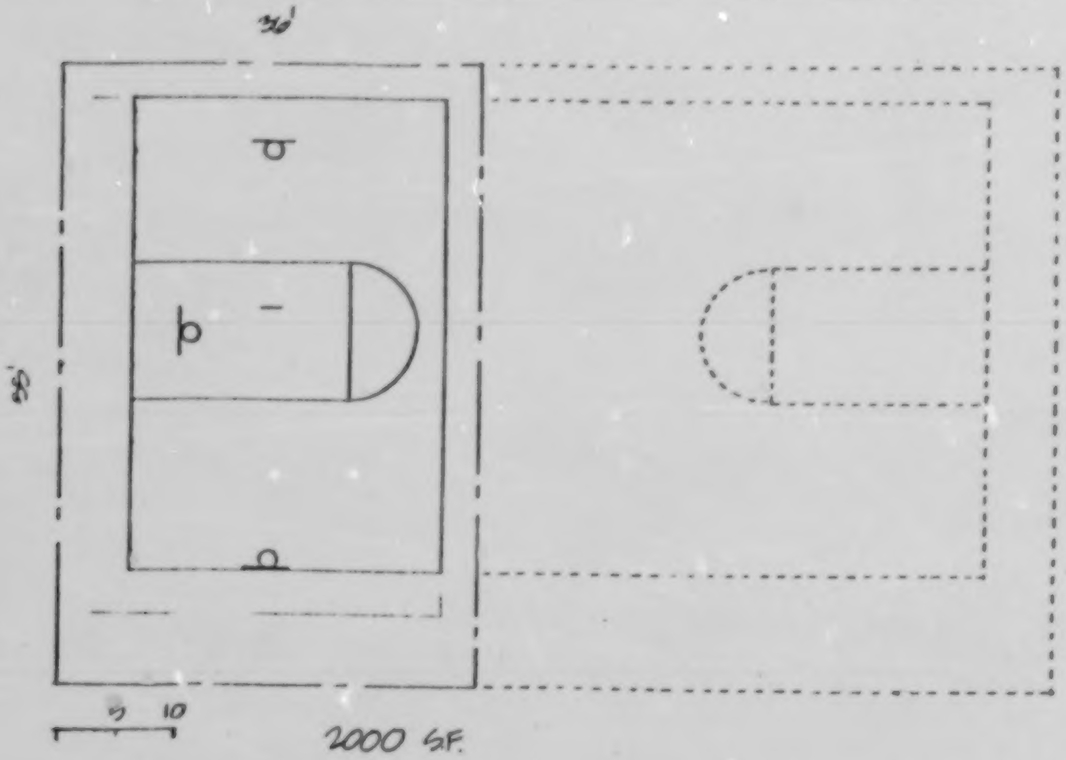
Mechanical:

1. Heating: 60-72 degrees F.
2. Ventilation: As required for greatest use demands.
3. Plumbing: As required by classroom program.

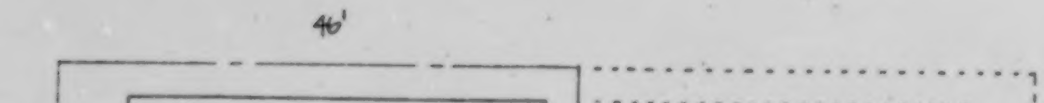
PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Physical Education:

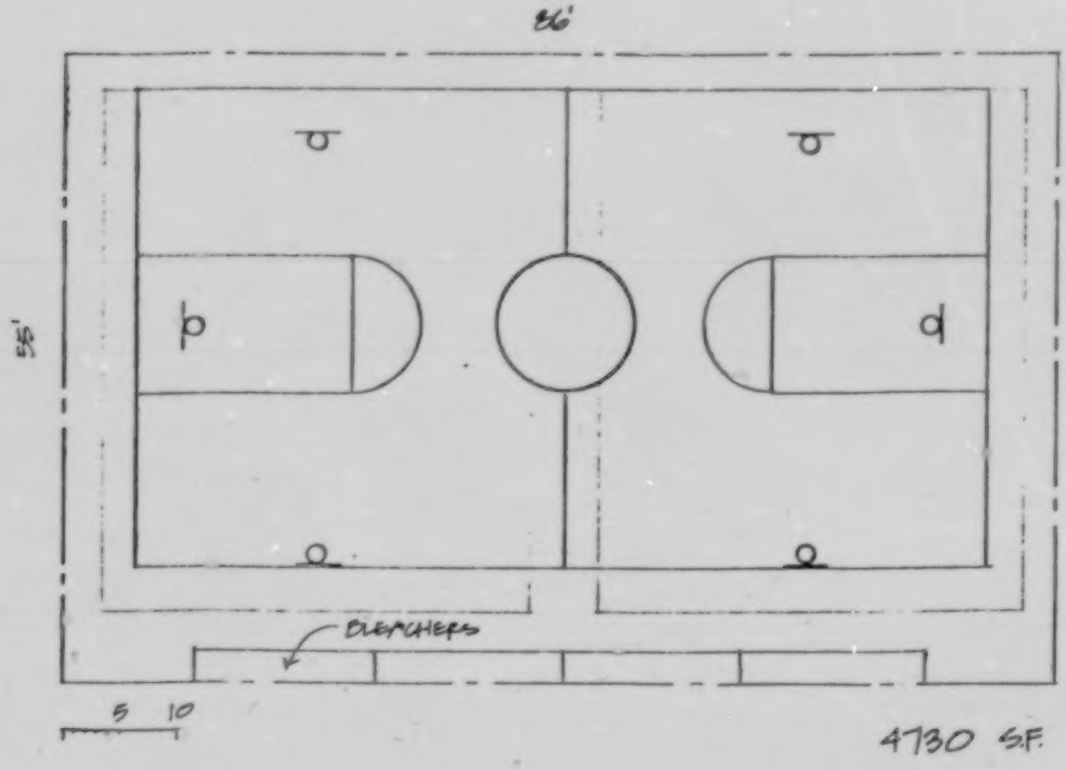
Item No.	Equipment List
a.	Tumbling mat (6 x 12 Ensolite) (1)
b.	Climbing rope
c.	Weight set
d.	Assortment of balls
e.	Basketball standards
f.	Volleyball standards
g.	Floor hockey equipment
h.	Wrestling mat
i.	Gym-scoots



2000 S.F.


46'
55'
BLEACHERS
5
10

2530 S.F.


86'
55'
BLEACHERS
5 10
4730 S.F.

6. SHOP

The Trades and Industries (T & I) program will be a program area of major interest in bush villages. The extent of the industrial education program in small high schools will be limited by the size of the facility, equipment, and fire code limitations. The thrust of the industrial education curriculum will be determined on a local and district level; the desired program space available and equipment layout must be closely coordinated with the designer to arrive at a realistic and functional arrangement. A Ken Cook Trans-national Learning Station will be utilized to supplement the desired program.

PHYSICAL CHARACTERISTICS

Size: 600 square feet.

Ceiling Height: 10-12 feet.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: High light reflectance; acoustic; fire resistant, as required.
2. Floors: Durable, nonabsorptive, nonskid (e.g., concrete topping is desirable; thin-set quarry tile or end grain wood is an alternate).
3. Ceiling: High light reflectance; acoustic.

Windows: 7'-6" minimum from floor, or eliminate.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC in work areas; guarded fixtures.
2. Power: 120/208-V., 3-phase; separate panelboard for industrial education power equipment with shunt trip main breaker or contactor controlled by emergency shutdown buttons.

Mechanical:

1. Heating: 67 degrees F. (to minimize injuries).
2. Ventilation: 5 CFM OSA/person, minimum. ASHRAE 62-73; plus special E/A requirements.
3. Woodshop: Sawdust collection requirements.

4. Metal Shop: Recirculating air purifier can be used for welding fumes.
5. Paint Finishing: Strict fire code requirements to be resolved in design.
6. Power Mechanics: Hazard area with special requirements.
7. Plumbing:
    a. Waste: Sand, grease, oil, solids interceptor; floor drains.
    b. Water: Sink with tempered water.

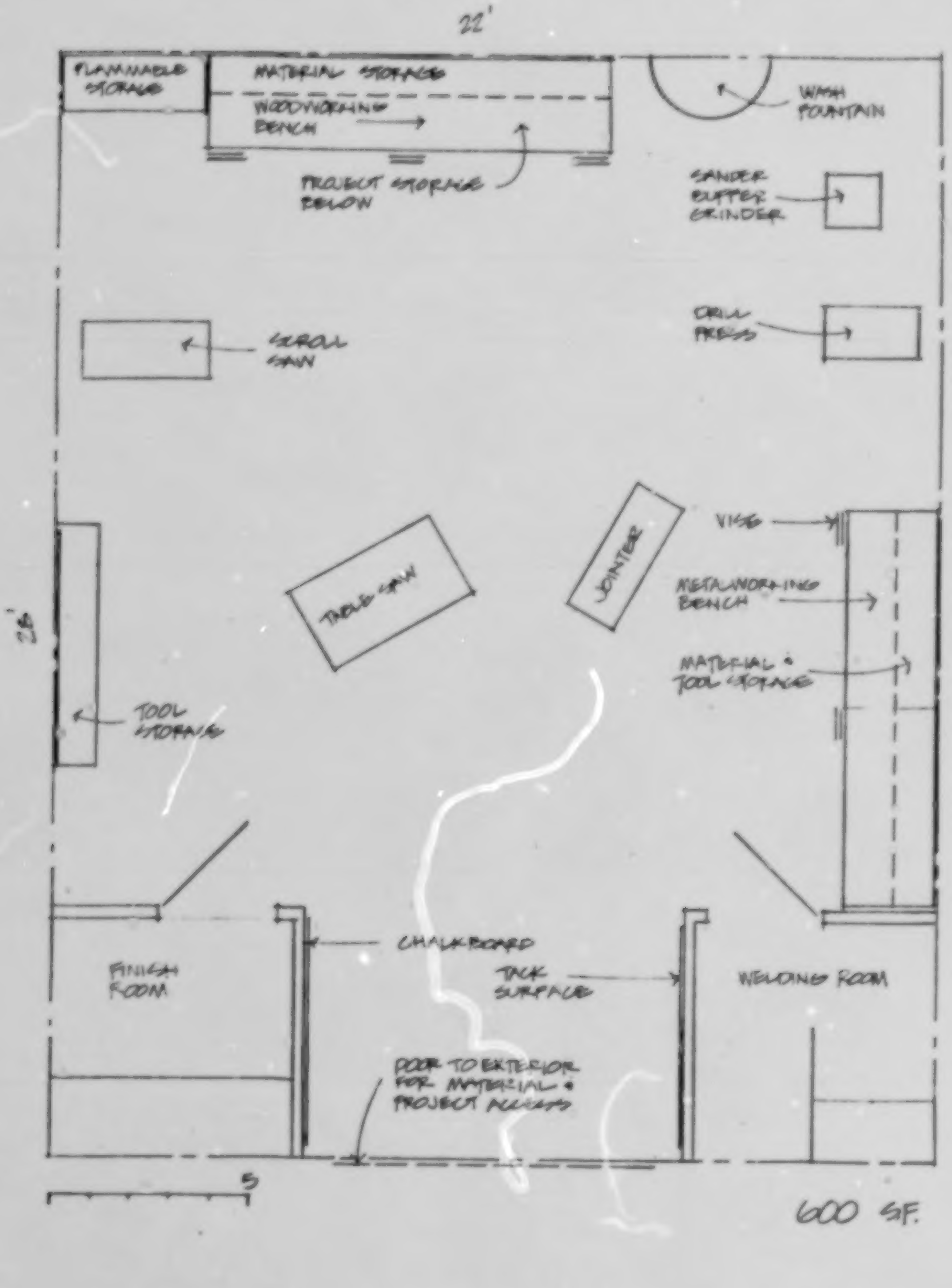
PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Industrial Education:

Item No.	Equipment List
a.	Chalk and tackboard
b.	4-student workbench (1)
c.	Drill press, 15" variable speed, w/1/2 HP motor (1)
d.	4" jointer w/1/3 HP motor (1)
e.	Table saw (1)
f.	Vise, machinist, swivel base, 5" jaw, opens to 6-1/2" (1)
g.	Builders saw, 7-1/4" (1)
h.	Bayonet saw kit (1)
i.	Belt sander, 3" x 21" (1)
j.	Disc sander, 7", 2/5/8 shaft (1)
k.	Drill, multispeed reversing, 1/2" (1)
l.	Drill, multispeed reversing, 1/4" (1)
m.	Miter box, 2/24 x 24" saw (1)
n.	Vise, woodworking, 4/10" jaw, open 12" (4)
o.	Tool storage cabinet (1)
p.	Ken Cook Trans-national Learning Station w/SR 100 A.V. desk (1)
q.	Assorted handbooks - both mechanics and woodworking (1)
r.	Power mechanics equipment (as programmed)
s.	Welding/metals equipment (as programmed)
t.	Finish booth
u.	Other equipment as program and space allow
v.	Material storage

Special Requirements:

1. Wash basin.
2. Dust exhaust systems.
3. Flammable liquid storage.
4. Fire code requirements for separation, use, and storage of materials and equipment, and integration of T & I activities.
5. Acetelene and oxygen tanks for welding program should be stored on a movable cart and kept in a warm area. The performance of these gases, for welding purposes, is affected by extreme cold.
6. Exterior access for materials and projects (ramp if above-grade).


22'
28'
FLAMMABLE STORAGE
MATERIAL STORAGE
WOODWORKING BENCH
PROJECT STORAGE BELOW
WASH FOUNTAIN
SANDER BUFFER GRINDER
DRILL PRESS
SCROLL SAW
TABLE SAW
JOINTER
VISE
METALWORKING BENCH
MATERIAL & TOOL STORAGE
TOOL STORAGE
CHALKBOARD
TACK SURFACE
FINISH ROOM
WELDING ROOM
DOOR TO EXTERIOR FOR MATERIAL & PROJECT ACCESS
5
600 S.F.

7. TEACHER OFFICE AREA/ADMINISTRATION

The teacher in the small school is a person of many responsibilities and functions. Teacher office areas must be accessible to students and allow for maximum area observation. Secure storage for student records and funds, and space for the school radio or CB must be provided. A multiuse room might be provided that would serve as a teacher prep area, administrative office, and audio-visual storage.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum

Materials: (Quality)

1. Walls: Acoustic.
2. Ceiling: Acoustic.
3. Floor: Acoustic.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC in work areas.
2. Power:
    a. Miscellaneous outlets.
    b. Radio, TV antennae, telephone.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Administration:

Item No.	Equipment List
a.	Desk and chair (3)
b.	4-drawer file cabinet with lock (3)
c.	Bookshelves
d.	Small conference table
e.	Secure storage for student records and money
f.	Telephone/radio/CB
g.	Typewriter and stand
h.	Coffee Pot

Special Requirements:

1. Power strip.
2. Task lighting.

SUPPLEMENTARY SPACE

8. TOILETS

The level of feasible service will be determined on a site-specific basis. Actual fixture counts will vary due to code interpretations, enrollment, utilization of facility, village population, and availability of water. In determining the number of fixtures required, consider the possibility of increased enrollment and community use. The following are facility recommendations for the 21-32 student enrollment group:

	Men	Women
Water Closets	2	2
Urinals	2	
Lavatories	2	2
Showers	2	2
Drinking Fountain	1	

PHYSICAL CHARACTERISTICS

Ceiling Height: 7.5 feet minimum.

Materials: (Quality)

1. Walls: Water resistant; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Water and wear resistant.

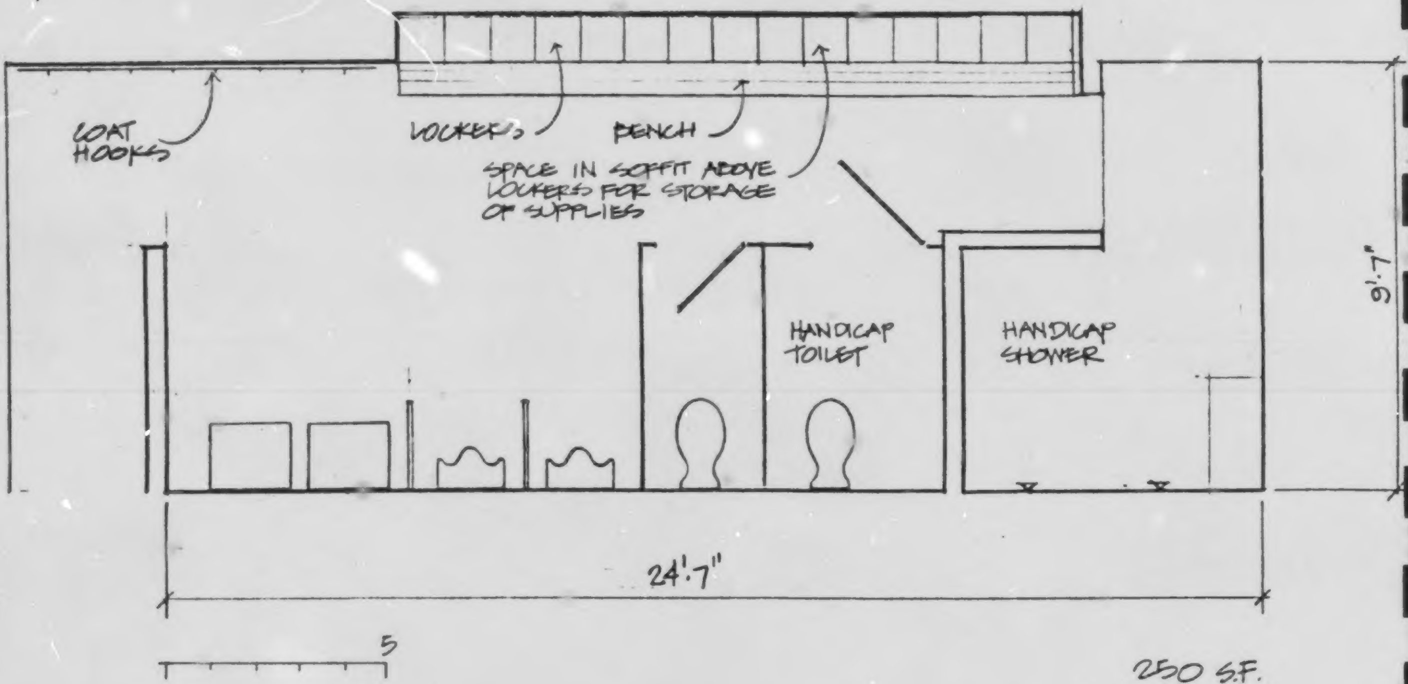
SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC; vapor-tight and vandalproof fixtures.
2. Power: Outlets ground fault protected.

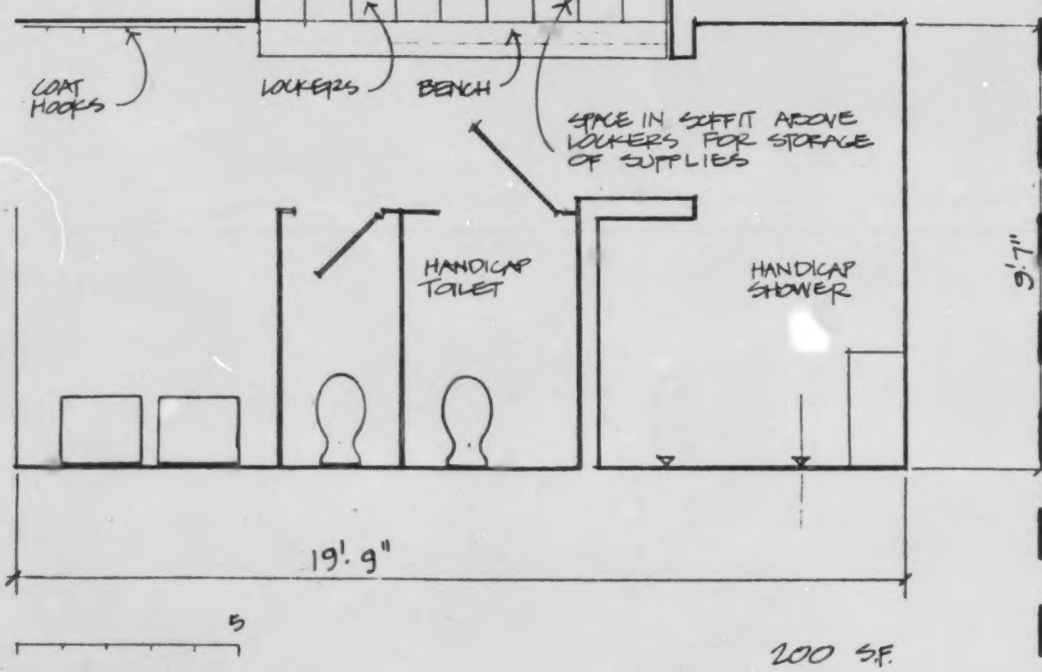
Mechanical:

1. Heating: 70-75 degrees F.
2. Plumbing (site-specific):
   a. Water - tempered.
3. Exhaust air.


COAT HOOKS
LOCKERS
BENCH
SPACE IN SOFFIT ABOVE LOCKERS FOR STORAGE OF SUPPLIES
HANDICAP TOILET
HANDICAP SHOWER
9'-7"
24'-7"
5

250 S.F.

MENS TOILET


COAT HOOKS
LOCKERS
BENCH
SPACE IN SOFFIT ABOVE LOCKERS FOR STORAGE OF SUPPLIES
HANDICAP TOILET
HANDICAP SHOWER
9'-7"
19'-9"
5

200 S.F.

WOMENS TOILET

SUPPLEMENTARY SPACE

9. MECHANICAL/ELECTRICAL AREAS

The mechanical room and electrical panel should be located on the main level and be easily accessible and close to an entry (not on an upper level or in an attic space).

The pending freeze-up danger and the unavailability of a local repair service with a spare parts inventory, increase the need for a well planned mechanical/electrical room. It is very important to provide enough room in this space to easily service all equipment. Too often in the early stages of design, this area is established by the architect without adequate consultation with the mechanical and electrical engineers. The failure of one of these systems, and an inability to have ready access for diagnosis and repair, can result in serious damage to the facility and its contents and loss of a school program. However, the room should be planned not to have more space than is needed for equipment servicing (including major replacement); too much space will result in unauthorized storage of materials in this room (a code violation). Doors, knock-out panels, or some means of egress for the largest piece of equipment must be provided for future replacement. The electrical and control panels should be located so that the net clear space (minimum 30 inches by code) in front of them must be used for circulation space within the mechanical room. This helps to prevent the storage of materials in front of the panels (panels may be located elsewhere in the building with these guidelines applied).

PHYSICAL CHARACTERISTICS

Size: 12'-6" x 13'-6" minimum (will vary with equipment used).

Ceiling Height: 9 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 808.

1. Walls: High light reflectance; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Combustible or noncombustible surface depending on fuel-fired equipment specified; noncombustible recommended to reduce fire hazard of absorbed fuel oil.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 20 FC.
2. Power: Two outlets; ground fault protected.

Mechanical:

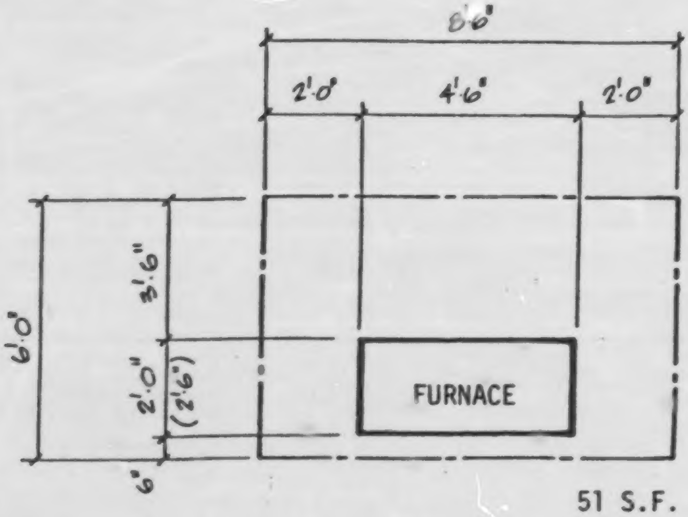
1. Fuel supply and day tank.
2. Three furnaces.
3. Hot water heater.
4. Space for chimneys.

CONCEPTUAL LAYOUT MECHANICAL/ELECTRICAL AREAS

Building Size: 6,480 S.F.

Note:

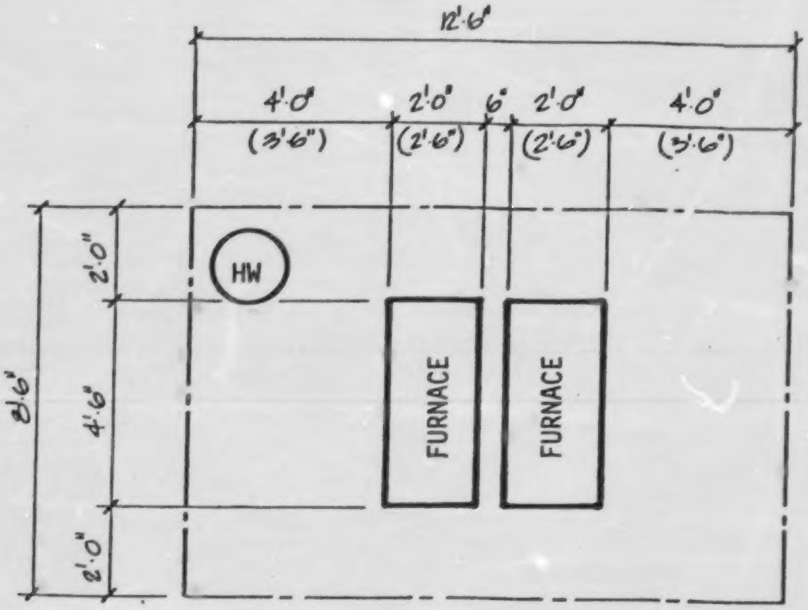
1. Heating load assumed to be 220,000 BTU/HR.
2. A simple "pot-type" oil-burning stove should be installed, centrally located to heat entire building under emergency conditions.
3. Hot Water Heater: Electric, 2 KW.



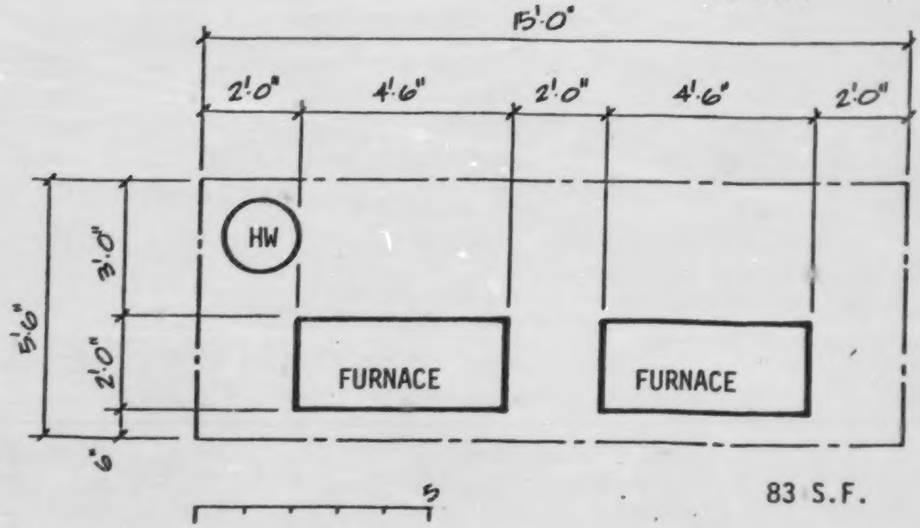
51 S.F.

(1) Furnace (No Standby):

BTU Each Furnace:	220,000
Furnace Dimensions:	30" x 40"
Furnace Room Dimensions:	6'-0 x 8'-6'


12'6"
4'0"
(3'6")
2'0"
(2'6")
6"
2'0"
(2'6")
4'0"
(3'6")
8'6"
2'0"
4'6"
2'0"
HW
FURNACE
FURNACE

100 S.F.


15'0"
2'0"
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3'0"
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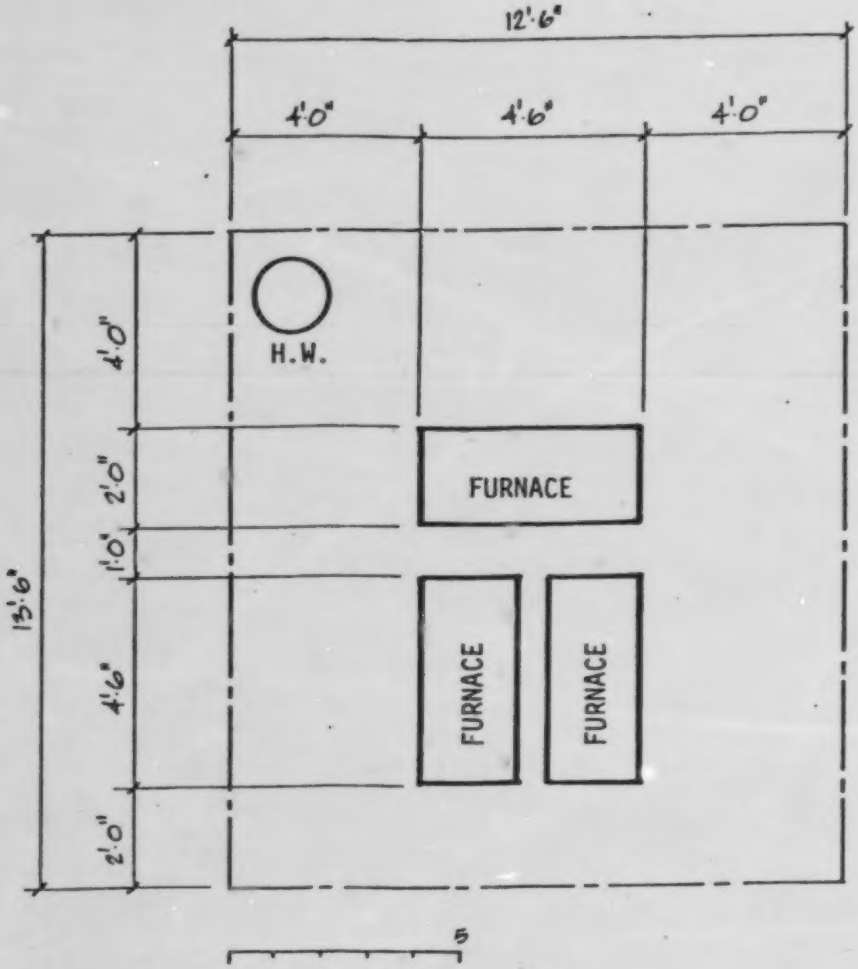
HW
FURNACE
FURNACE
5

83 S.F.

(2) Furnaces (75% of Full Load Each):

BTU Each Furnace: 140,000
Furnace Dimensions: 24" x 54"
Furnace Room Dimensions: 8'-6" x 12'-6"


12'-6"
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FURNACE
FURNACE
FURNACE
13'-6"
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2'-0"
1'-0"
4'-6"
2'-0"
5

(3) Furnaces (50% of Full Load Each):

BTU Each Furnace: 95,000
Furnace Dimensions: 24" x 54"
Furnace Room Dimensions: 12'-6" x 13'-6"

SUPPLEMENTARY SPACE

10. MAINTENANCE ROOM

The maintenance room is provided within the small rural high school as a space for building repair, daily cleaning, and storage. It is required by building code that this space not be part of the fuel-fired equipment room. Workbench and storage shelving should be carefully planned and built-in to prevent this space from being used for unauthorized purposes. This room must be large enough to house all cleaning equipment (vacuum, mops, ladder, cart, brooms, etc.), a minimum quantity of cleaning supplies and products, a mop sink, a workbench (30" x 60"), and storage for tools, manuals, maintenance records, and spare parts. This space must be well lighted, accessible, and adequately sized to meet the needs of the local maintenance program requirements. Usually the maintenance room will be located on a plumbing wall adjacent to the toilet areas to minimize plumbing runs.

PHYSICAL CHARACTERISTICS

Size: 76 square feet minimum.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Construction; see UBC, Section 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: General 30 FC, and 70 FC for task lighting over workbench.
2. Power: Three outlets; ground fault protected (one at workbench height).

Mechanical:

1. Plumbing: Site-specific.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Maintenance:

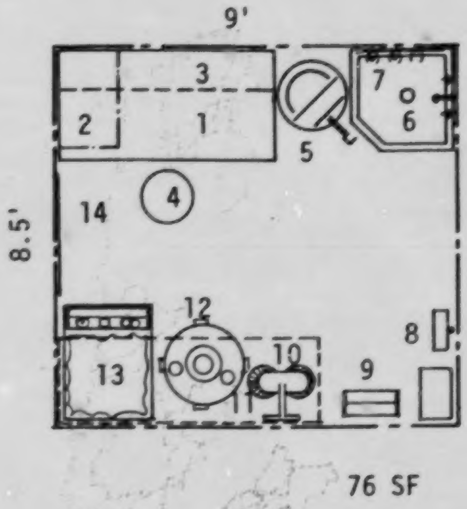
Item No.	Equipment List
a.	Mop sink
b.	Mop rack
c.	Shelving (above and below workbench)
d.	Vacuum cleaner, hose, and attachments
e.	Janitorial cart (optional)
f.	Ladder
g.	Miscellaneous cleaning supplies (gallon containers)
h.	Miscellaneous paper products (2 weeks supply)
i.	Building maintenance tools
j.	Large push broom
k.	Large push dustmop
l.	Snow shovel, ice chipping tool
m.	Wet mops
n.	Mop bucket with wheels and wringer
o.	Vise
p.	Tool box
q.	2-drawer file cabinet

Special Requirements:

1. Workbench with metal surface.

CONCEPTUAL LAYOUT MAINTENANCE ROOM

1. WORK BENCH W/METAL SURFACE
2. 2 DRAWER FILE CABINET
3. TOOL & PARTS STORAGE
4. STOOL
5. MOP BUCKET
6. MOP SINK
7. MOP & BROOM RACKS
8. SHOVEL & MISCELLANEOUS BUILDING MAINTENNANCE TOOLS
9. STEP LADDER
10. FLOOR CLEANER
11. PAPER & CLEANING SUPPLY STORAGE
12. VACUUM CLEANER
13. JANITORIAL CART
14. PORTABLE SCAFFOLD



SUPPLEMENTARY SPACE

11. CIRCULATION

The defined circulation space in the facility for 21-32 students will vary according to whether the design is an open or traditional plan. In an open-plan concept, actual circulation space exists, but is calculated as a part of the assignable classroom area. Efficiency calculations of assignable and unassignable space may be misleading. In either case, circulation paths should avoid dissecting a program area, and should instead be used to emphasize teaching stations and minimize disruptions. The corridor may be used as an acoustic buffer between quiet and noise-producing areas, e.g., between multipurpose and academic areas, but may also act as a conductor of unwanted sound from noisy to quiet spaces. The corridor may also be utilized as a distribution spine for utilities, i.e., plumbing overhead and waste below the floor.

The minimizing of the total space devoted to circulation should be a design goal. In determining the widths of exit corridors, the design should include an occupant load based upon use of the multipurpose room by the entire community.

The design of circulation space as an exit corridor will need to comply with the State Fire Marshal's current code interpretations if an alcove off this space is to be used for storage of students' coats and books. [1] Handicap maneuverability, clearance, and surface finish requirements must be taken into consideration when designing circulation paths.

PHYSICAL CHARACTERISTICS

Width: Exit Corridors - 6 feet minimum.

Ceiling Height: 8 feet minimum recommended.

Material: (Quality). Exit Corridors - see UBC, Section 3304(g).

1. Walls: Durable; readily cleanable; moderate light reflectance.
2. Floors: Acoustic; color should mask effects of soiling. (At Entries: absorptive and/or readily cleanable and water resistant surfaces).
3. Ceiling: Durable; acoustic.

Windows: Desirable to provide psychological relief.

[1] Taken from Minutes of Meeting on 6/30/78 with State Fire Marshal. Subject to reinterpretation by State Fire Marshal's office; reader to confirm details.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: Variable 20-30 FC, general area. Increased lighting in display and planting areas.
2. Power: Miscellaneous outlets.

Mechanical:

1. Heating: 70 degrees F.
2. Drinking Fountain: Where applicable (per handicap requirements).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Student coat and book storage
b.	Display cabinets (optional)
c.	Seating (optional)
d.	Tack surfaces

SUPPLEMENTARY SPACE

12. GENERAL STORAGE

Adequate storage specifications will be site-specific. Each particular school district must develop specifications according to its purchasing-stocking-shipping requirements and the specific logistics of each site. One option for cold storage is to provide a more cheaply constructed, separate, unheated storage building on the school site. Often, existing structures can be cheaply modified for storage use. A creative custodian and school staff can maximize storage space if unneeded items are disposed of and material inventories are carefully monitored (one small school was found annually ordering envelopes without realizing they had an 80 year supply). Suggestions that help assure that the storage room is used as programmed include shelving installed at construction, a minimum of circulation space, minimum electrical outlets, and utilization of odd shaped "left-over" areas. Long-term storage can be provided in attics and mezzanines when provided with access that is convenient and heavy enough for carrying the supplies to the space; however, all storage rooms must be One-hour Fire-resistive Construction. If the storage room is located on the second level, the State Fire Marshal is currently classifying the facility as a 2-story structure due to the potential of the storage room being used as a classroom. (See Section 5.40).

Three separate storage areas are needed for each school to provide for:

1. Plant Support Materials: Toilet paper, extra pipe, spare parts, cleaning supplies, oil, etc.
2. General Instructional Supplies: Books, paper, audio-visual equipment, etc.
3. Food Storage: (Food must be stored on shelves or pallets above the floor, and food must not be stored in classrooms or the boiler room).

PHYSICAL CHARACTERISTICS

Size: (site-specific).

1. Plant Support Materials: 120 square feet.
2. General Instructional Supplies: 120 square feet.
3. Food Storage: 126 square feet; Class "A" lunch program.

Ceiling Height: Varies (if less than 6'-6", this can be considered "bonus" space according to DOT/PF Design Standards for Space Utilization).

Materials: One-hour Fire-resistive Construction Per UBC 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Varies (use minimum required).

Mechanical:

1. Heated or Unheated: Varies (site-specific).
    a. Plant Support Materials: Above 32 degrees F.
    b. Food Storage: Cold - 0 degrees F.; Dry Goods - 60 degrees F. or below.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Industrial grade adjustable shelving w/12" wide shelves.

SUPPLEMENTARY SPACE

13. FOOD SERVICE

The food service program for a secondary school of 21-32 students will depend on several factors:

1. Local village priority for food service program versus other programs.
2. Ability of secondary school to share use of food service program at elementary school, or in the other instance, the need to provide for a combined food service program as a part of the secondary school.
3. Type and extent of food service program to be offered by the school district.

The food service program is a major operational expenditure. To reduce operating costs, some districts are switching their program from the traditional hot lunch to a program where frozen dinners are heated in convection ovens and served to the students with disposable dishes and utensils. This not only cuts down on the cost per meal, but also reduces the need for an elaborate kitchen, minimizes staffing, and allows more space and budget to be devoted to operating the educational program. In some villages, this frozen dinner program may not be popular if it causes a reduction in local employment.

The frozen dinner program does not need a separate kitchen and may utilize home science equipment provided in the lab area. However, if the food service program is to be included as a part of the lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. If proper sanitizing for dishwashing is unavailable, disposable dishes and utensils must be used for the food service program as well as for home science. If the lab is utilized for this type of food service program, additional space must be provided for the storage of dry goods, frozen goods, and paper products depending on frequency of delivery. It may also be desirable to specify a commercial convection oven.

Government subsidies are available to districts to help defray the cost of the food service program as long as the program complies with Federal standards. Subsidies, local employment, and demand may keep the traditional hot lunch program as a feasible program in many districts; in this case, additional space must be programmed into a facility to accommodate food preparation and dry and cold storage.

GENERAL GUIDE FOR FREEZER SPACE

	NUMBER OF LUNCHES SERVED DAILY		
Delivery Intervals	25-100	100-300	300-500
Monthly	50 cu. ft. (reach-in or upright)	132 cu. ft. (8 x 10')	560 cu. ft. (8 x 10') walk-in
3 Months	132 cu. ft.	560 cu. ft. 80 sq. ft. (8 x 10')	672 cu. ft. 96 sq. ft. (8 x 12')
6 Months	560 cu. ft. (80 sq. ft.)	672 cu. ft. (96 sq. ft.)	1120 cu. ft. (160 sq. ft.)

Figures are based on 30 lbs. storage per cu. foot.

PHYSICAL CHARACTERISTICS

Size: 650 s.f. minimum.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable.
3. Ceiling: Washable.
4. Base: Coved, washable.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC general area; 70 FC task lighting; vapor-tight fixtures.
2. Power: 120/208-V., 3-phase; load varies with equipment.

Mechanical:

1. Heating: 65 degrees F.
2. Ventilation: Use range hood; draw make-up air from adjacent areas.
3. Plumbing:
   a. Waste: Sink requires grease trap which presents problems with or without this unit.
   b. Water: Hot and cold. Sanitizing water (140 degrees F.) required if washing dishes or utensils.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Frozen Dinner Program:

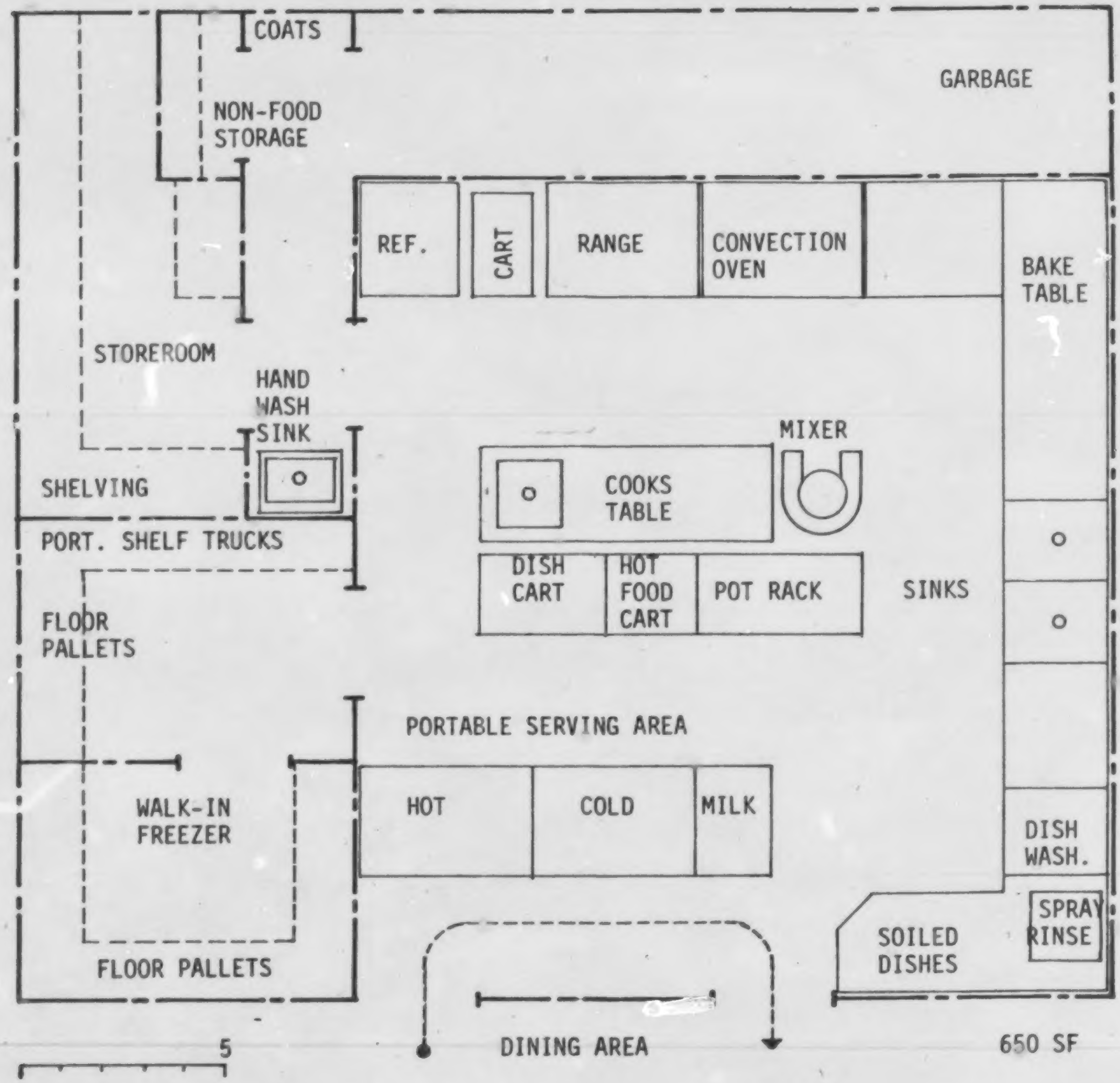
Item No.	Equipment List
a.	Convection oven
b.	Sink
c.	Disposable dishes and utensil storage
d.	Dry goods storage
e.	Frozen goods storage
f.	Refrigerator
g.	Exhaust hood

Traditional Hot Lunch:

Item No.	Equipment List
a.	Range with oven, 36" (1)
b.	Oven, convection (1)
c.	Stock pots (varies)
d.	Mixer with attachments (1-20 qt.)
e.	Dishwasher or 3-compartment sink with drainboard
f.	Handwash sink
g.	Refrigerator
h.	Freezer
i.	Cook's table with drawers and rack
j.	Pot and pan storage rack
k.	Exhaust hood
l.	Utility cart, 3- shelf
m.	Fire extinguisher
n.	Microwave oven
o.	Student seating tables and storage

Special Requirements:

1. Propane won't flow in extreme cold. Tanks must be stored in warm area.


COATS
GARBAGE
NON-FOOD STORAGE
REF.
CART
RANGE
CONVECTION OVEN
BAKE TABLE
STOREROOM
HAND WASH SINK
MIXER
SHELVING
COOKS TABLE
PORT. SHELF TRUCKS
DISH CART
HOT FOOD CART
POT RACK
SINKS
FLOOR PALLETS
PORTABLE SERVING AREA
WALK-IN FREEZER
HOT
COLD
MILK
DISH WASH.
SPRAY RINSE
SOILED DISHES
FLOOR PALLETS
DINING AREA
650 SF
5

Plan developed by Amelia E. Snell, R.D.
Furnished by DOE

KITCHEN - SERVING 25-100 STUDENTS

SUPPLEMENTARY SPACE

14. ON-SITE GENERATION

Some level of on-site electrical generation will be required at nearly every site. Size, type, and number of generating units will vary according to the size of the school and the availability, reliability, and cost of commercial power (see discussion in Section 9.42, Building Utilities). Levels of on-site generation will be divided into three general categories:

> Level One; Minimum Standby: On-site generation of minimum capacity required to keep essential systems operating to prevent damage to the school during commercial power outages. Unit is sized to power a few lights and building heating equipment. Use of the school would not be possible while on standby power. This level of on-site generation would be applicable to those sites having reasonably reliable commercial power systems where power outages would be expected to occur infrequently and be of short duration.
>
> Level Two; Full Standby: On-site generation with sufficient capacity to allow normal operation of the school during loss of commercial power. Standby generation would be provided by a single unit sized to accommodate the full load requirement of the school. This level of on-site generation would apply where outages of several days' duration can be expected.
>
> Level Three; 100% On-Site Generation: On-site generation to provide 100 percent of the school's electrical energy would consist of two generating units sized to accommodate the school's full load requirements, plus one smaller generating unit for night and weekend loads. This level of on-site generation would apply where commercial power is unavailable, too unreliable, or too costly to be used.

Space requirements for any level of on-site generation must allow easy access to both sides and rear (generator end) of each generating unit for maintenance and repair. Space must also be provided for proper clearance in front of switchgear, and for working clearance around any auxiliary equipment. For Level Three generation, workbench space should be provided, in addition to the workbench space provided in the school maintenance room.

Space for Level One generation might be provided within the school building itself. As an alternative, Level One generation could be provided by a portable, air-cooled, fully enclosed unit which is moved from storage into place outside the school and plugged into an exterior connection when needed.

Level Two and Three generation should be installed in a building separated from the school and all other buildings by at least 20 feet for fire and noise reasons.

PHYSICAL CHARACTERISTICS

Size: Varies with level of on-site generation and physical size of generating units:

Level One: 90 square feet.
Level Two: 120 square feet.
Level Three: 264 square feet.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Table 5-B.

1. Walls: Taped gypsum board.
2. Ceiling: Taped gypsum board.
3. Floor: Nonabsorptive, nonslip (metal with ababrasive finish; light weight concrete).

SERVICE REQUIREMENTS

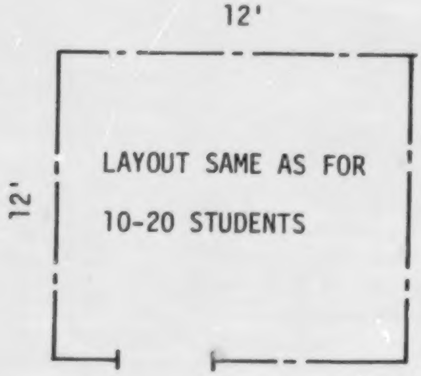
Electrical:

1. Power: Convenience outlets located around perimeter of generator building, approximately 10 feet on center. Convenience outlets over workbench. Power for jacket water tank heater.
2. Lighting: 20-30 FC, general lighting; 70 FC task lighting over bench.

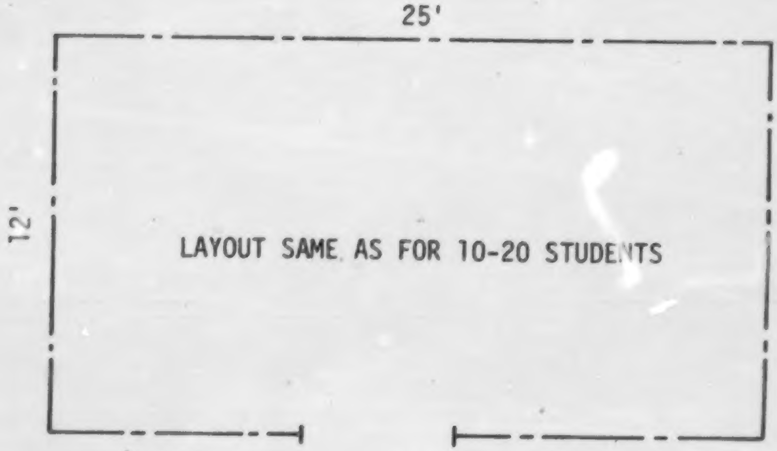
Mechanical:

1. Fuel supply.
2. Cooling air for generator and jacket water, combustion air for engine.
3. Waste heat equipment (Level Three).
4. Fire Suppression: Halon or CO2 system.

LEVEL ONE SAME AS FOR 10-20 STUDENTS


12'
12'
LAYOUT SAME AS FOR
10-20 STUDENTS

LEVEL TWO


25'
12'
LAYOUT SAME AS FOR 10-20 STUDENTS

LEVEL THREE

SUPPLEMENTARY SPACE 15. WATER UTILITY

For those villages with central piped distribution systems, space allocation for water service should take no floor space unless a small recirculation pump is required. In case of the latter, provision for access to the pump for periodic maintenance should be provided. (See Section 6.1 for water system options, and Section 3.1 for water system determinants).

For newly developed school sources, space allocation for water utility pressurization, treatment, and pumping will be necessary. The location of a water utility area should be on the main floor and easily accessible. Daily monitoring of treatment is necessary. If located on an upper level, access shall be by a full-sized stairway. Space set aside for storage of chemicals and replacement/repair of mechanical equipment should be analyzed by the architect. Many villages have annual delivery service only by barge, and high air freight delivery costs should be compared to the initial cost of providing annual storage space for items needed to maintain the water utility.

Protection from freezing is mandatory. Failure of the water system may not stop operation of the teaching program, but will result in loss of capital investment as well as providing a hardship. The occurrence of communicable disease is high in those villages without a central system; often, the villagers look to the school as the only safe potable water supply.

Design of the system for a maximum six-year projected enrollment will allow for reasonable future expansion. A minimum of 25 gallons per person per day is a recommended minimum where water sources availability permits.

Use of storage tanks as a wintertime supply will require additional space for heating for equipment that provides freeze protection. Sizing of the tank should be based on the longest expected freezing time of the source, with an additional buffer for concentration of contaminants at the bottom of the tank.

Connection of the water supply to the building should take the differential movement of each into consideration. Use of insulated flexible connections is recommended.

Additional treatment of water may be required for schools where the water source is high in turbidity, color, iron, etc. Physical-chemical treatment requires vessels with flow rates of approximately three gallons per minute per square foot of area. This additional treatment should probably occur in a separate building or in an area that is nonaccessible to the public.

PHYSICAL CHARACTERISTICS

Size: Varies with equipment used. Minimum 36 square feet.

Ceiling Height: 7.5 feet minimum.

Materials:

1. Walls: High light reflectance, washable. Chemical resistance in storage areas.
2. Ceiling: High light reflectance, washable.
3. Floors: Impermeable, noncombustible depending on heating equipment used for equipment room or storage tanks.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Heating: Above freezing.
2. Plumbing: site-specific.
3. Supplementary fuel supply.
4. Chlorination system.
5. Filtration system (pressure filter, rapid sand filter).

Optional:

6. Aeration tower.
7. Flocculation chamber.
8. Ion-exchange filters.
9. Permanganate green sand filters.
10. Fluoridation system.

SUPPLEMENTARY SPACE

16. WASTE WATER DISPOSAL

Connection of the building sewer line to an existing sewer system should take no additional space when a gravity sewer service line is used. If a pump is necessary to move the sewage into the existing utility, then a sump may be required at some point in the building, probably below floor elevation. Sump pumps may also be required for moving sewage to a treatment plant or septic tank. Sumps could be located with easy and complete access through the floor from "supplemental" space above. The enclosure for sumps must be very well insulated with nonmoisture susceptible insulation; additional heat may be needed here as it is at a low elevation within the building.

Septic tanks are usually installed outside the building and underground; thus, they would require no space within the building. Other similar alternatives such as a lagoon or pond disposal would require no building space other than a possible sump pump as stated above.

Nonwater-borne waste disposal as found in chemical, humus, or incinerating toilets, may need additional space to allow proper handling of wastes such as holding tanks and "honey buckets". Special access to such toilets may be desirable from an esthetic point of view. Methods of collecting such waste may dictate location in the building.

When a sewage treatment plant within the building is deemed the best solution, additional storage space will be required for chemicals used in treatment. The frequency of delivery of such chemicals will dictate the amount of storage required.

Capacity for future expansion can be adequately handled by designing for a projected enrollment as discussed in Section 6.2. The size of the treatment plant listed below is based on 15 gallons per capita per day for schools without multipurpose rooms and showers and 25 gallons per capita per day for schools with multipurpose rooms and showers.

PHYSICAL CHARACTERISTICS

Size: Equipment would occupy about 7' x 7'. Added clearance for maintenance would bring the total area to 120 square feet.

Ceiling Height: Depends on type of unit. If pumps must be lifted above tanks for maintenance and repair, ceiling height may need to be as much as 15 feet.

Materials:

1. Walls: Good light reflectance, washable, chemical resistant.
2. Ceilings: Same as walls.
3. Floors: Impermeable, sloped to drain with emergency overflow provisions.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: To handle up to two HP., two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Temperature: Above freezing.
2. Plumbing: To handle flows.
3. Heating: Separate from rest of building.
4. Ventilation: Separate from rest of building.
5. Chlorination: Usually in tablet form; no power required.

General: Space requirements for packaged sewage treatment plants will vary with models available. Sizes are not standardized. Different methods of treatment would dictate size also. "Batch" treatment requires waste water storage at beginning of process, which may increase the space requirement. Sizes of packaged treatment plants are usually supplied in increment sizes that would accommodate more than one size of school.

SPACE SUMMARY:

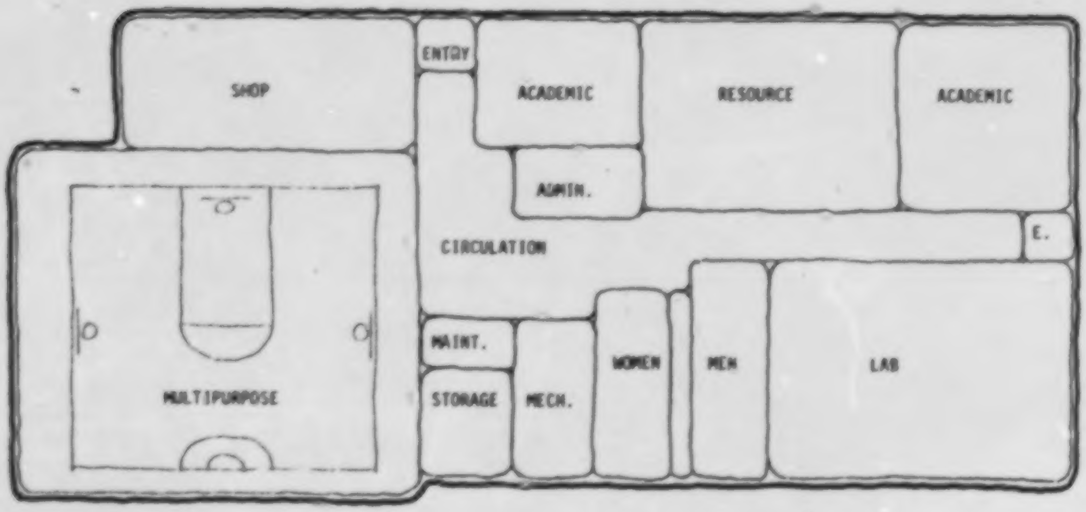
Student Enrollment	21-32
Classroom(s)	1,200 1/
Library/Media Center (% of Individual Study Space)	1,000 75%
Science Classroom	-0-
Office	-0-
Business Education	-0-
Home Science	-0-
Industrial Education	600
Multipurpose Space	2,000
Supplementary Space	1,680 (26% of Gross)
Restrooms Storage Hallways Wall Thickness Kitchens Mechanical Space	
TOTAL	6,480 S.F.

1/ Includes wet area for Science/Home Economics.

The secondary school for 33-46 students will be a total facility of approximately 8,800 square feet, of which 6,800 square feet will be designed for various high school programs and approximately 2,000 square feet will be needed for supplementary space, e.g., toilets, maintenance room, mechanical room, and general storage.

A school of this size will be staffed by two or three teachers, depending, of course, on school district policy and the availability of funds. For planning purposes, allow space for three. Besides functioning as a teacher, one staff member will also function as the principal and assume responsibility for total operation of the school program and facility.

Program requirements, activities, and space requirements will influence the division of assignable space into program areas. Three basic concepts of organizing program spaces are illustrated in the following figures.



TRADITIONAL PLAN

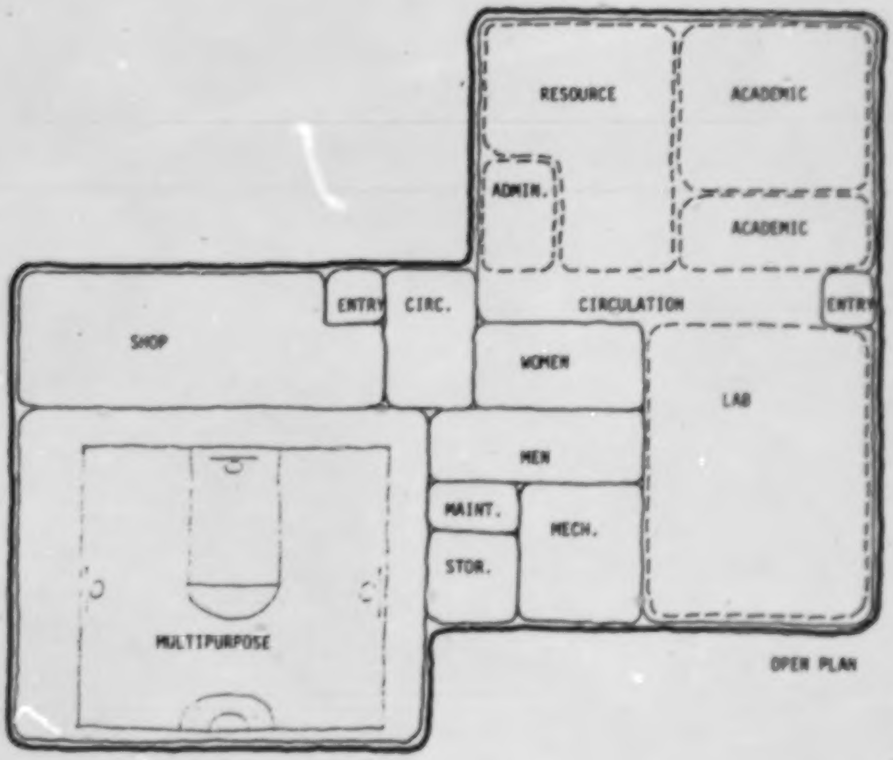
The traditional plan illustrated above is a classic example of organizing educational and supplementary space. This concept is characterized by the use of fixed classrooms and corridors.

1. Advantages:

   a. Generally preferred by teachers.
   b. Minimizes both visual and acoustical distractions.

2. Disadvantages:

   a. Lack of flexibility for changes in enrollment and program.
   b. Limits teacher's supervision ability to one area.
   c. Total plan will have a higher percentage of unassignable space due to having defined corridors.
   d. First cost of building partitions versus open space will be higher.


RESOURCE
ACADEMIC
ADMIN.
ACADEMIC
SHOP
ENTRY
CIRC.
CIRCULATION
ENTRY
WOMEN
LAB
MEN
MAINT.
MECH.
STOR.
MULTIPURPOSE

OPEN PLAN

The open-plan concept combines all of the teaching areas into one "open" space and uses movable partitions and furniture to define program areas.

1. Advantages:

   a. Allows for greater flexibility in program and enrollment.
   b. Reduces first cost of construction.

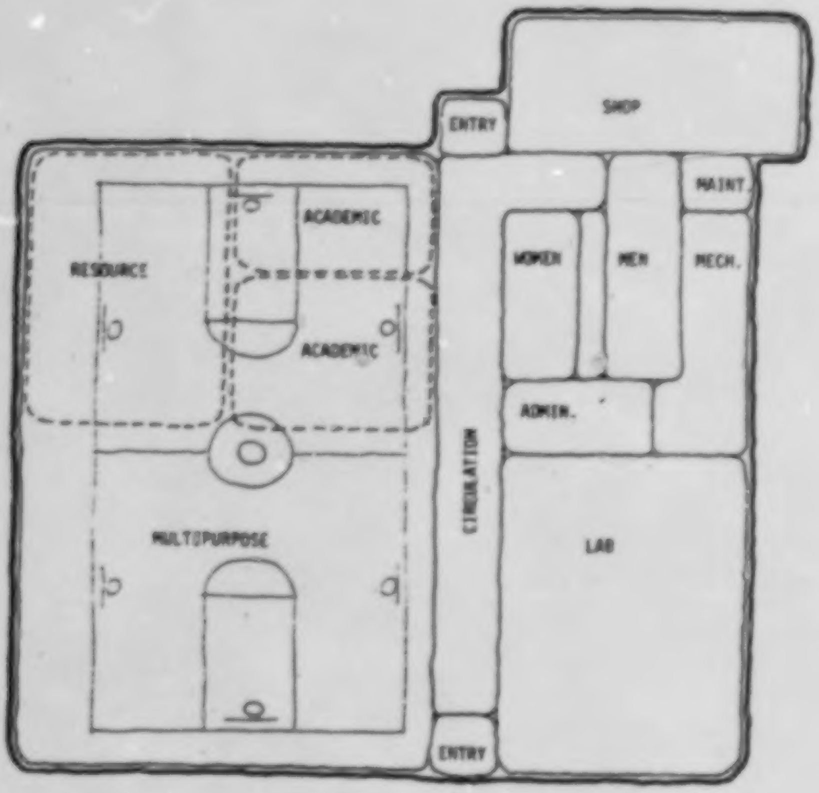
c. Will give a higher percentage of assignable space because the circulation space is included in the classroom area. The plan will appear more efficient.

d. Allows for a teacher to supervise more than one area at the same time.

e. Easier to make service modifications, i.e., mechanical/ electrical.

2. Disadvantages:

a. Acoustic and visual distractions can be potential problems. The open plan will require well coordinated program space planning, interior design, and acoustical engineering to produce good academic areas.


SHOP
ENTRY
MAINT.
ACADEMIC
RESOURCE
WOMEN
MEN
MECH.
ACADEMIC
ADMIN.
CIRCULATION
MULTIPURPOSE
LAB
ENTRY

FLEXIBLE-USE PLAN

A local or district desire to increase multipurpose area could be accomplished by combining academic, resource, and multipurpose spaces together, forming a flexible use plan as illustrated above. While this will increase space available for recreation, there will be a trade-off for acoustics and a traditional classroom atmosphere.

1. Advantages:

   a. This concept has the ability to maximize multipurpose space which, in many villages, will also be used by elementary students and the community.

2. Disadvantages:

   a. It is projected that the first cost of this scheme will be greater due to the need to provide expensive acoustic separation and treatment to allow for classroom activities. The increased volume would also add to the construction cost.
   b. It is uncertain how well this space will function for classroom activities. The multiuse concept may place an additional burden on teachers.

Acoustical separation of noise-producing areas, such as the shop from classroom areas, is achieved in the conceptual plans by remotely locating the two activities. Service cores and corridors can be utilized as buffers between acoustically noncompatible program areas.

In reviewing the three conceptual plans, you will note that a specific kitchen or food service area has not been indicated on these illustrations. In most villages, an elementary school with an on-going food service program will already exist. It will be determined by each school district how the food service program for the secondary school is to be handled.

Whether or not a food service program is provided as part of the secondary school, and to what extent, will have major effects on the allocation of space, sizing of mechanical systems, selection of materials, and general layout of the school plan.

The food service program, general storage, and site utilities, e.g., water, waste water, power generation, are additional program items that must be incorporated into the design as determined by specific site conditions, budget limitations, and district priorities.

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Science	Students dissecting various animals and plants; performing chemical experiments; mixing fuming chemicals; sorting, categorizing and storing various rocks, plants, animals, and sea life, and putting them in display cases; viewing films.	Lab (Project Area)
Math	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 5-15: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Language Arts	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips.	Academic Area

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Language Arts (Con't.)	Discussion: Groups of 5-15: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area (Con't.)
Social Studies	Passive: Total group or class: listening to lectures, watching demonstrations, viewing films/filmstrips. Discussion: Groups of 5-15: face-to-face seating arrangement with writing surface, with or without teacher. Sometimes group projects requiring physical activity are involved. Individual Study: Reading, writing, listening/viewing tapes, video-tapes, slides, and filmstrips.	Academic Area
Physical Education	Description of Activities: Passive: Total class or total school holding assemblies, viewing movies and/or stage plays.	Multipurpose

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Physical Education (Con't.)	Individual Skill Practice and Dual Sports: Groups of 5-46 practicing skills and participating in fitness and related physical education activities (e.g., wrestling, calisthenics, gymnastics, archery, table tennis, shuffleboard, four-square, weight training, etc.). Team Skills: Groups of 5-20 practicing skills and participating in team activities (e.g., basketball, floor hockey, volleyball, flag football, soccer, softball, etc.). Community Use: Passive: Total community viewing of movies, watching plays and Christmas programs; holding community meetings; dances; festivals. Individual and Team Sports: Various groups from the community participating in fitness and related physical education activities and team sports (e.g., basketball, shuffleboard, weight training, volleyball, softball, etc.).	Multipurpose (Con't.)

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Electives:		
Home Science	Small groups of students working in the four skill areas of cooking, sewing, homemaking, and child care, as well as passively reviewing TV and films as a group, and slide and/or filmstrips; cassette tape presentations as a group or as individuals. Cooking: Frying, baking, mixing, washing dishes, measuring, cooking, freezing. Sewing: Measuring, laying out, sewing, cutting, pressing or ironing, etc. Homemaking: Interior design, entertainment, food storage, family living, cleaning, washing and drying clothes, home nursing. Child Care: Dressing, feeding, holding, entertaining, observing.	Lab (Project Area)
Business Education	Typing: Students will in general be working individually or in groups of 1-8. Students will learn individually studying in carrels using slide-tape machine and typewriters.	Lab Area or Sound Module

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Business Education (Con't.)	Office Practice: Students will learn and work individually with various office machines.	Sound Module or Lab Area (Con't.)
Music	1) Performing: (a) Singing (b) Playing instruments, optional w/sound module. 2) Listening 3) Creating	Academic Area
Art	1) Painting 2) Drawing 3) Pottery Making 4) Carving 5) Printmaking 6) Constructing 7) Forming 8) Weaving 9) Etching.	Lab (Project Area)
Trade & Industries	Assembling, disassembling small engines; measuring, sawing, fitting, gluing, nailing, sanding, building, blueprint reading, drafting; welding/metals optional.	Shop
Library/Media	The focus of the academic area is envisioned to be the learning resource center. It is the depository for teaching resources, and provides space for individual learning. It should be readily accessible to individuals and groups and	Resource Area w/Carrels

PROGRAM REQUIREMENTS	DESCRIPTION OF ACTIVITIES	SPACE REQUIREMENTS
Library/Media	should be closely related to specialized learning laboratories. One of the major components in the learning resource center which can bridge both learning and social differences between remote areas and the outside world is the audio-visual information center. Here a well-supplied source of learning materials can bring the world of today into the classroom for all students.	Resource Area w/Carrels (Con't.)
Auxiliary Services:		
Administration	Counseling students individually or in small groups; greeting and/or talking to parents and other groups; filing reports, permanent records, typing reports, conducting phone and radio communications, duplicating of teaching material, and testing.	Teacher Office Area/Administration
Food Service	Extent of activity to be determined by school district and availability of other existing facilities.	Lab or Food Service Area; Storage - Cold and Dry

1. ACADEMIC AREA

For the 33-46 enrollment group, two or three academic areas should be provided depending on the size of the projected staff. The academic area should provide for conventional educational experiences, but should be flexible enough to accommodate changes in enrollment, learning-group sizes, activity requirements, and teaching methods. The academic area should provide for instruction in the following program areas: math, social studies, language arts, music, and other electives.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Material: (Quality)

1. Walls: High light reflectance.
2. Floors: Acoustic; color should resist effects of soiling.
3. Ceiling: Acoustic.

Windows: Windows are desirable to provide psychological relief, back-up ventilation, and emergency exits, but their use must be limited to minimize heat loss and potential distraction.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at desks and chalkboard.
2. Power: Two outlets or power poles on each wall.
3. TV jack.
4. Clock (battery).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Math:

Item No.	Equipment List
a.	Chalk and tackboards
b.	Student seating (1-25); desks or tables
c.	Overhead projector
d.	Tape recorder with headsets

e. Math lab supplies kit
f. Calculators (hand)
g. Projection screen (wall or ceiling mounted)

Special Requirements:

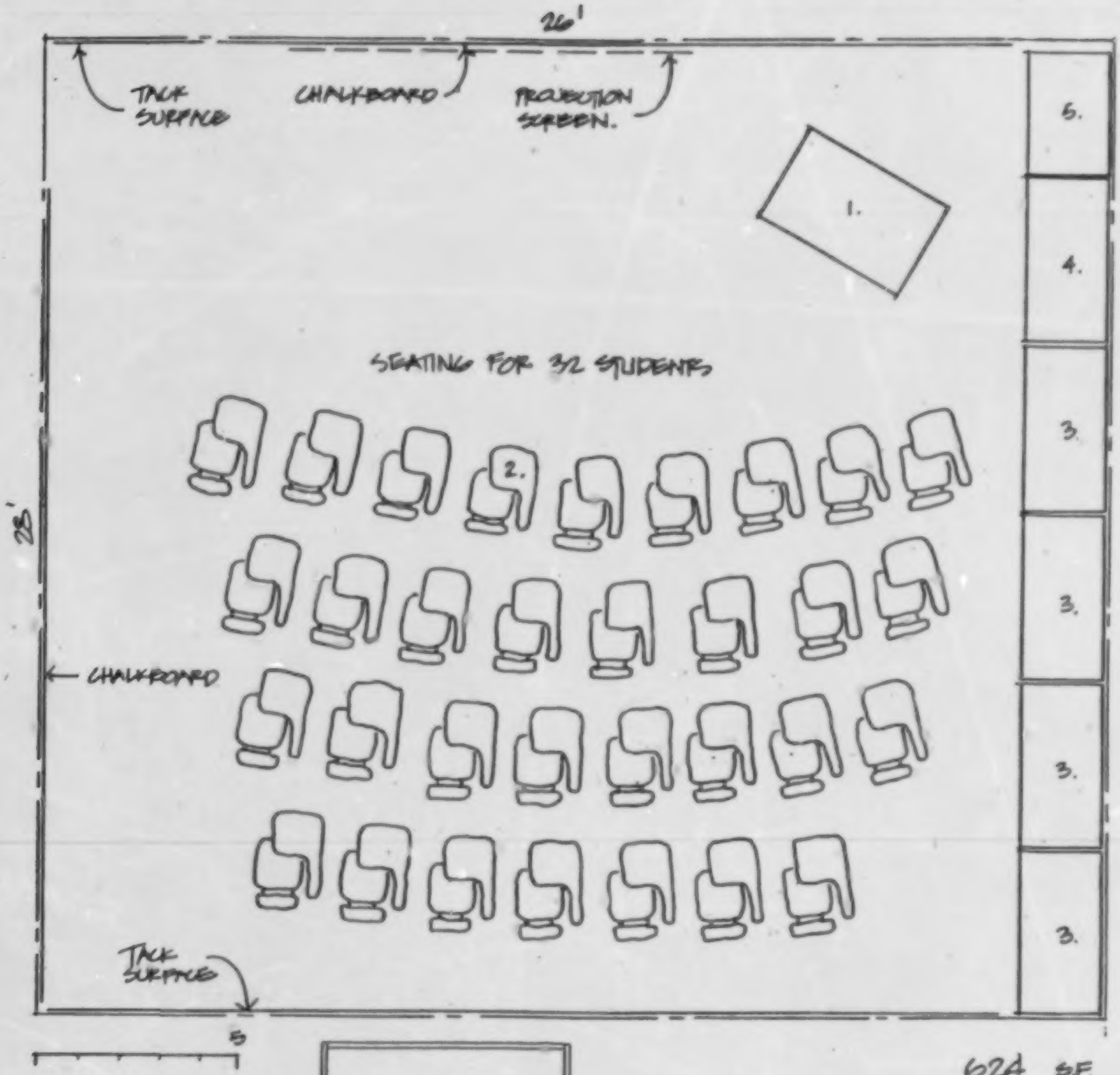
1. Power strip.
2. Project storage space (tote trays).
3. TV jack.

Language Arts:

Item No.	Equipment List
a.	Same as Math (not including calculators)

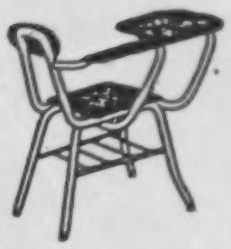
Social Studies:

Item No.	Equipment List
a.	Same as Math and Language Arts

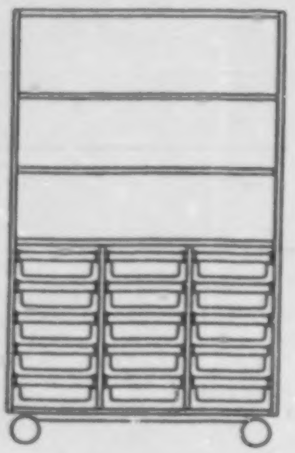

26'
TACK SURFACE
CHALKBOARD
PROJECTION SCREEN.
5.
1.
4.
3.
3.
3.
3.
SEATING FOR 32 STUDENTS
2.
28'
CHALKBOARD
TACK SURFACE
5

624 S.F.

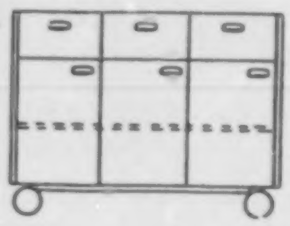
1. DESK OR TABLE



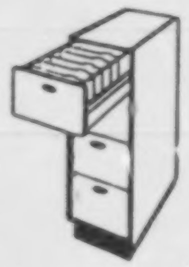
2. STUDENT DESK



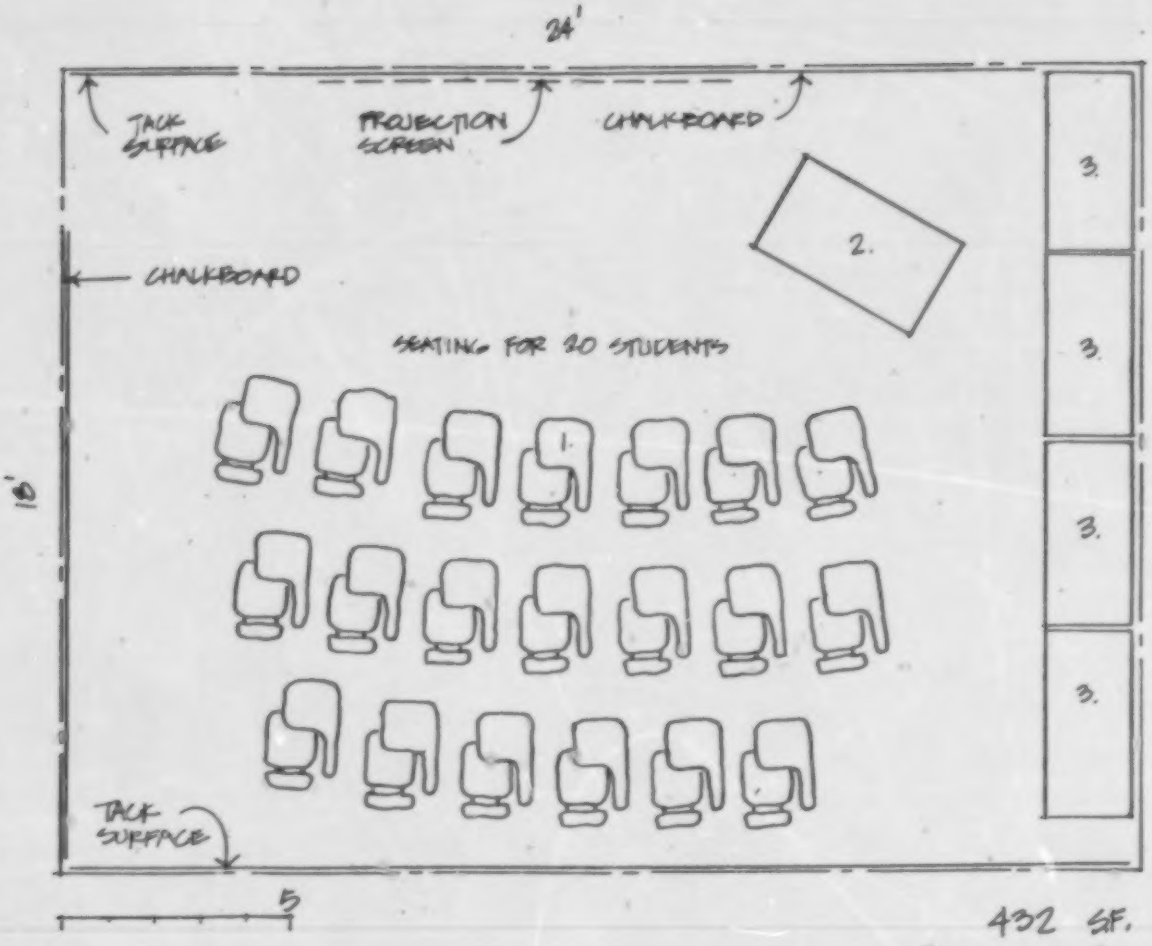
3. SHELVING & TOTE TRAYS

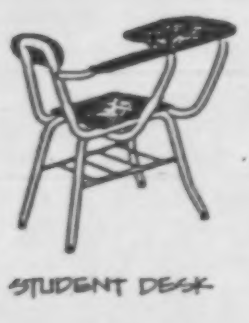


4. DRAWERS & CABINET

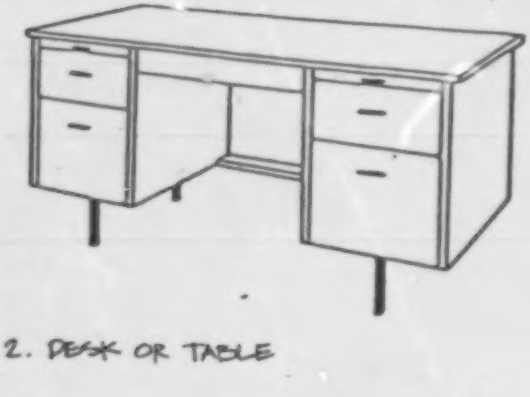


5. FILE CABINET

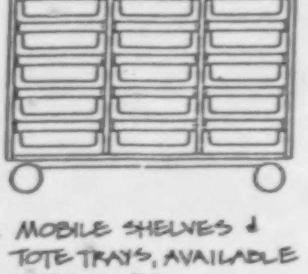

24'
TACK SURFACE
PROJECTION SCREEN
CHALKBOARD
CHALKBOARD
2.
3.
3.
3.
3.
SEATING FOR 20 STUDENTS
1.
18'
TACK SURFACE
5
432 SF.



1. STUDENT DESK



2. DESK OR TABLE



3. MOBILE SHELVES & TOTE TRAYS, AVAILABLE WITH DOORS

2. LAB (PROJECT AREA)

Two planning options are available for designing lab space for the 33-46 enrollment group. One option is to accommodate science, home science, and art all in one lab area. The other option is to provide two lab areas, using one for home science (and possibly food service), and the other for science and art. Regardless of the option utilized, the facility should allow for ease in adaptation from one program to another. If the food service program is to be included as a part of the lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. The business education program may also use the lab area as a teaching center. Tables may be used in common with other programs; additional storage for business equipment would have to be provided. Careful planning for storage of all equipment and student projects for each activity, along with the specification of multiuse counter areas and furniture, will be necessary to achieve a functional design. A separate food service area might be provided, but this will decrease available space for other programs. Ideally, the secondary school might share usage of an existing food service facility in a nearby elementary school.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: (Quality). One-hour Fire-Resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable (e.g., V.A.T.).
3. Ceiling: Washable finish.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC at counter and table tops.
2. Power:
    a. Plugstrip around walls above countertop.
    b. 120/208-V., 3-phase.
    c. TV jack.

Mechanical:

1. Ventilation: Noxious fume exhaust; rangehood exhaust.
2. Plumbing:
   a. Hot and cold water.
   b. Acid-resistant waste pipes (Science).
   c. Plaster trap in sink (Art).
   d. Gas for Bunsen burner desired (Science).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Science:

Item No.	Equipment List
a.	Mobile student science cart (2)
b.	Science table w/acid-resistant top and 4 stools (4)
c.	Microscope (8)
d.	Plant study kit
e.	Electricity kit
f.	Simple machines kit
g.	Weather station
h.	Aquarium, 10 gallon
i.	Terrarium, 10 gallon
j.	Scale and spring balance - 15 kg. capacity (4)
k.	Rock and mineral collection
l.	Dissecting set (advanced type for 8)
m.	Hot plate - 660 W., double unit (2)
n.	Ammeter
o.	Pump (hand-air vacuum and pressure)
p.	Basic set of chemicals (provide locked storage)
q.	Assorted test tubes and flasks
r.	Assortment of science charts
s.	Project storage

Special Requirements:

1. Storage cabinet with locking doors.
2. Sink (chemical and abrasion resistant).
3. Noxious fume exhaust.
4. Bunsen burner hook-up (desired).
5. Built-in display cases (desired).
6. Electrical outlets: minimum of 4, plug strip desired.
7. Chalk and tackboard.
8. Storage for flammable liquids.

Home Science:

Item No.	Equipment List
a.	Kitchen range, 4 burner stove
b.	Double sink
c.	Base cabinets with counter
d.	Overhead storage cabinets
e.	Assortment of small appliances (storage space to be provided)
f.	Portable sewing machine (4)
g.	Table with 4 chairs (3)
h.	Fitting mirror
i.	Dressing area (curtains)
j.	Ironing board, wall type (3)
k.	Tote drawer cabinet
l.	First aid kit
m.	Washer/dryer (optional)
n.	Assorted dishes, pots, and pans
o.	Refrigerator/freezer
p.	Microwave oven (optional)
q.	File cabinets

Special Requirements:

1. Plug strips.
2. 140 degree hot water (desirable).
3. Chalk and tackboards.
4. TV jack.
5. Vent hood.

Art:

Item No.	Equipment List
a.	Table with 6 chairs (3)
b.	Drawing boards (12)
c.	Easel (4)
d.	Assortment of supplies
e.	Project storage
f.	Double sink with plaster trap
g.	Display space
h.	Chalk and tackboards

Food Service:

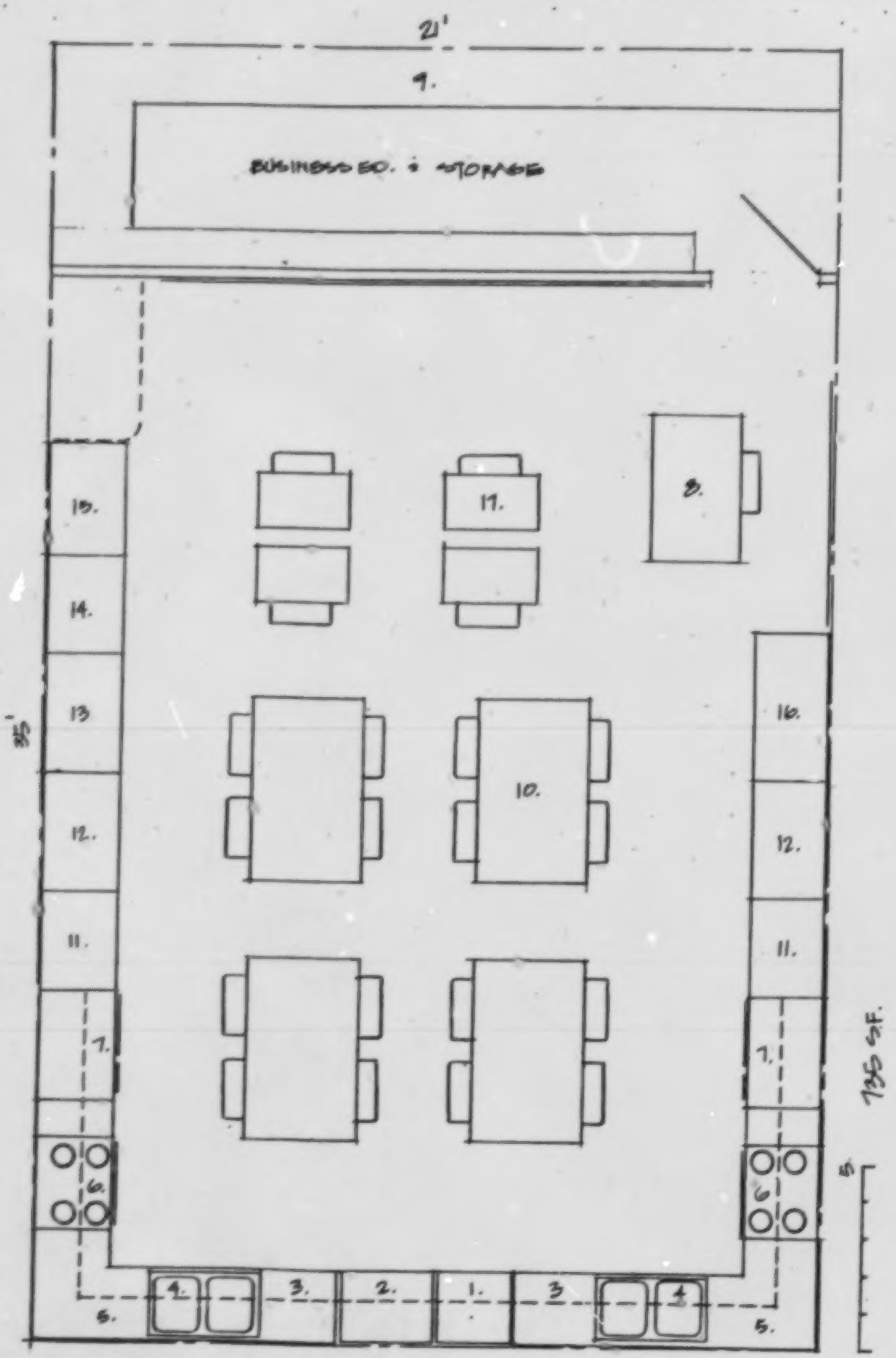
Item No.	Equipment List
a.	Stove
b.	Microwave oven
c.	Refrigerator/freezer
d.	Food, utensil, and paper storage
e.	Sink

Business Education:

Item No.	Equipment List
a.	Typewriters (2)
b.	Office machines, e.g., adding machine, printing electric calculator, duplicating machine
c.	Chalk and tackboards

	Special Requirements
1.	Acoustic treatment.

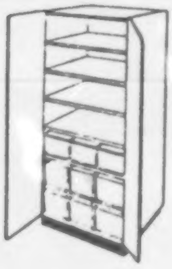
CONCEPTUAL LAYOUT LAB (PROJECT AREA)


21'
9.
BUSINESS ED. & STORAGE
35'
15.
14.
13
12.
11.
7.
6.
5.
4.
3.
2.
1.
3
4
5.
17.
8.
10.
16.
12.
11.
7.
6
735 S.F.
5.

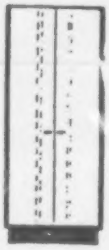
HOME SCIENCE/BUSINESS EDUCATION

HOME SCIENCE / BUSINESS

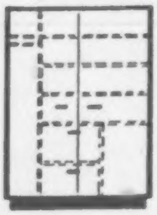
1. WASHER
2. DRYER
3. BASE CABINETS W/COUNTER
4. STAINLESS STEEL SINK
5. WALL HUNG CABINETS
6. 4 BURNER RANGE
7. REFRIGERATOR/FREEZER
8. TEACHERS DESK OR TABLE
9. SHELVING & COUNTERS FOR BUSINESS EDUCATION EQUIPMENT AND SUPPLIES
10. TABLE & CHAIRS



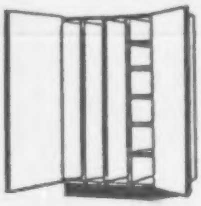
11. FOOD & STAPLES



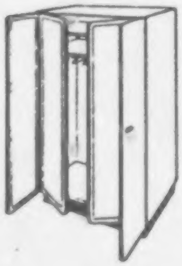
12. TOTE TRAYS (42)



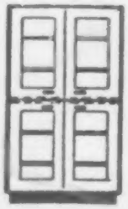
13. MISC. STORAGE



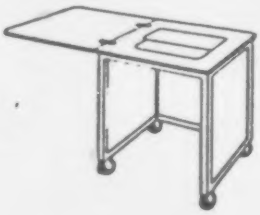
14. IRONING BOARD STORAGE



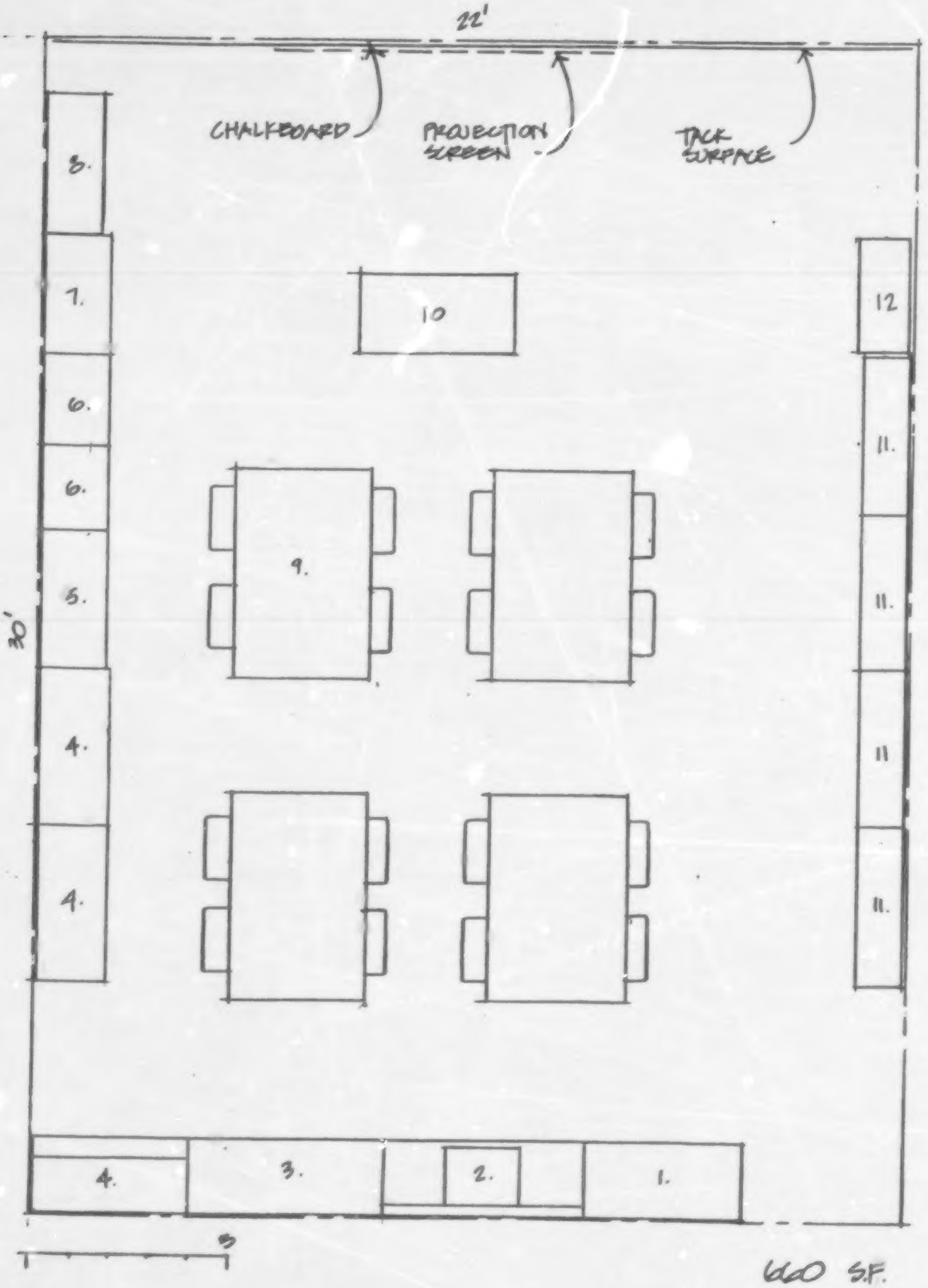
15. FITTING MIRROR & WARDROBE



16. DISPLAY & STORAGE

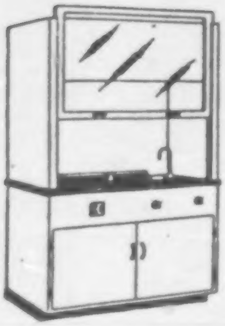


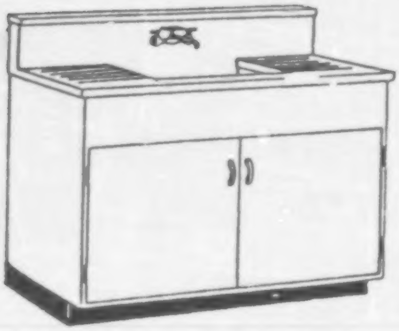
17. SEWING MACHINE TABLE

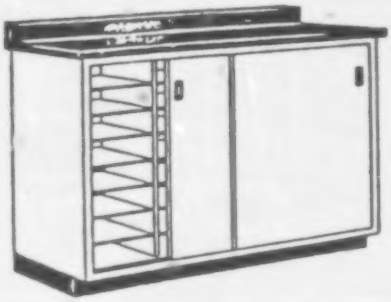

22'
CHALKBOARD
PROJECTION SCREEN
TACK SURFACE
30'
8.
7.
6.
6.
5.
4.
4.
10
9.
12
11.
11.
11
11.
4.
3.
2.
1.
5

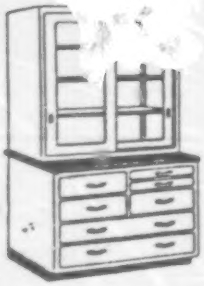
660 S.F.
SCIENCE

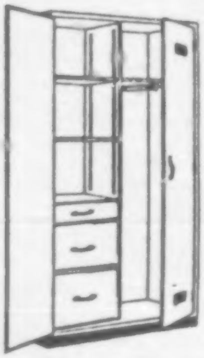
SCIENCE

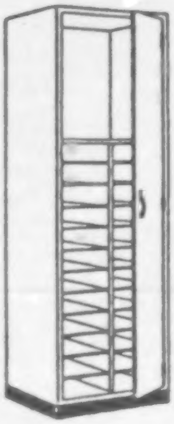

1. FUME HOOD.

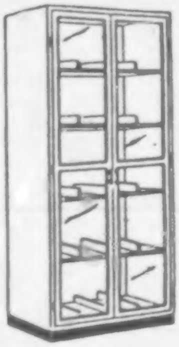

2. WALL SINK

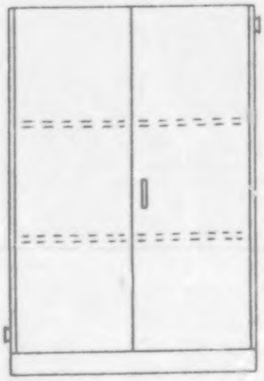

3. TOTE TRAY CASE

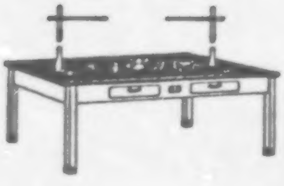

4. DISPLAY & SUPPLY CASE

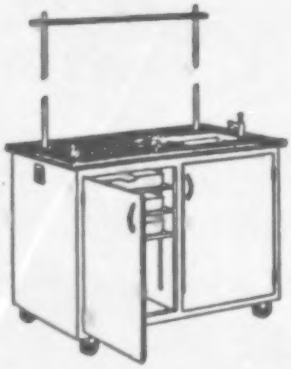

5. WARDROBE & SUPPLY

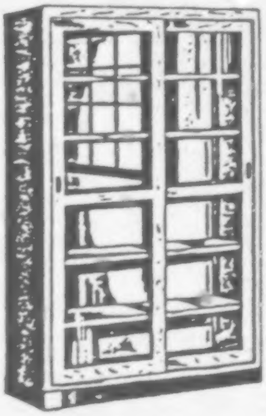

6. TOTE TRAY STORAGE

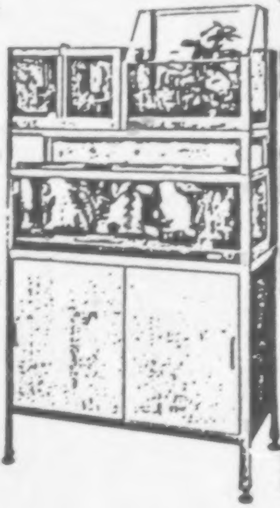

7. MICROSCOPE CASE


8. FLAMMABLE STORAGE


9. 4 STUDENT TABLE


10. MOBILE INSTRUCTOR'S DESK


11. STORAGE & DISPLAY


12. BIO LAB.

3. RESOURCE AREA

The resource area is the focal point of the educational environment in the small high school. This area will be used primarily for individualized study, but may also be used for instruction and to provide for an informal seating and meeting area. This area will be the primary depository and distribution point for educational materials and equipment, e.g., books, tapes, films, projectors, recorders, etc.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials:

1. Walls: High light reflectance; acoustic.
2. Ceiling: Acoustic.
3. Floors: Acoustic; color selection to minimize effects of soiling.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: Variable; 70 FC on desks in reading/study area.
2. Power: Plugstrip around walls and power poles in center to provide power for carrels.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Library/Media:

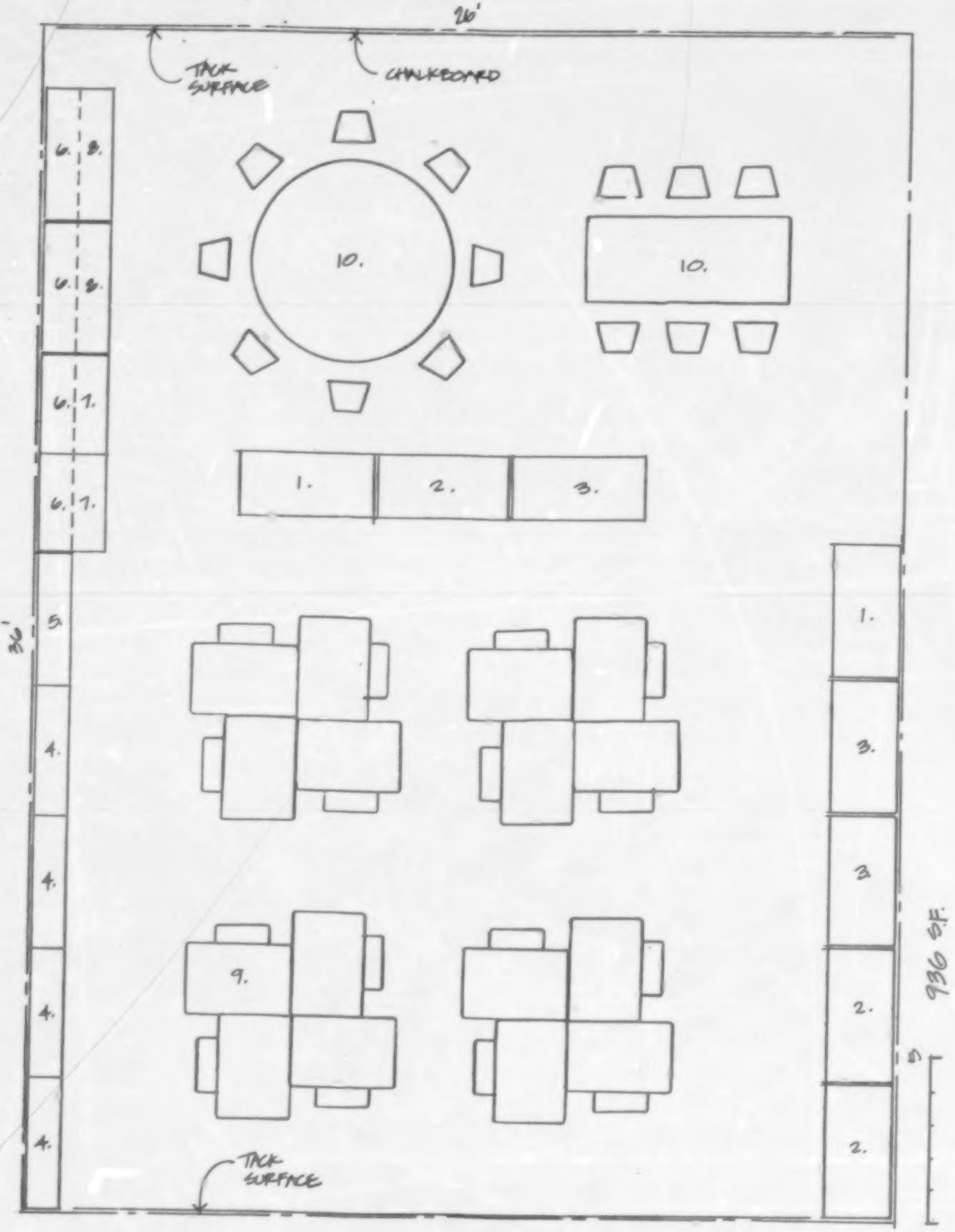
Item No.	Equipment List
a.	Seating for (25) (Total)
b.	Carrels (15)
c.	Books and periodical storage

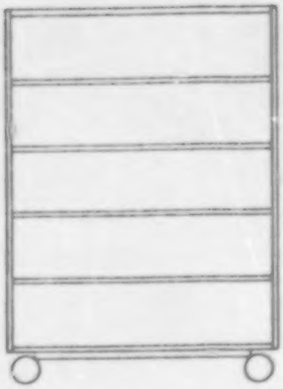
d. A/V equipment storage:
   - 16 mm. projector
   - 35 mm. slide/filmstrip projector
   - Overhead projector
   - Microfilm viewer
   - Video-tape recorder/player
   - TV camera
   - Cassette and video-tape storage

e. TV jack

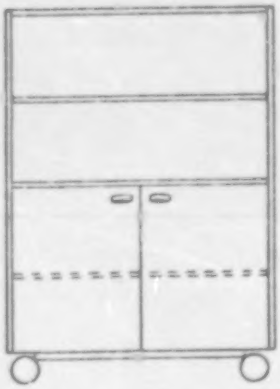
Special Requirements:

1. Power plugs or poles.
2. Task lighting.

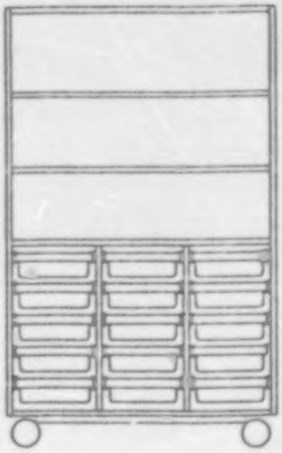

26'
TACK SURFACE
CHALKBOARD
6. 8.
6. 8.
6. 7.
6. 7.
10.
10.
1.
2.
3.
36'
5.
4.
4.
4.
4.
1.
3.
3
2.
2.
9.
936 S.F.
5
TACK SURFACE



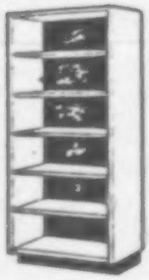
1. MOBILE BOOKSHELF



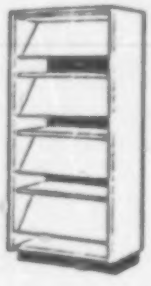
2. MOBILE BOOKSHELF & CABINET



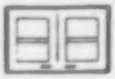
3. MOBILE BOOKSHELF & TOTE TRAYS



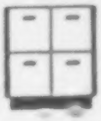
4. BOOKSHELF



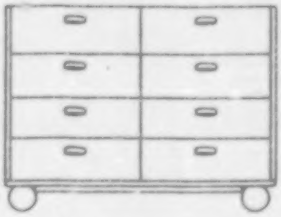
5. MAGAZINE SHELVING



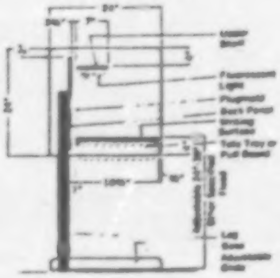
6. WALL CABINET



7. FILE CABINET



8. MOBILE DRAWERS



Upper Shelf
Fluorescent Light
Pegboard
Back Panel
Writing Surface
Tote Tray or Pull Board
Leg
Base
Adjustable Glide

9. STUDY CARREL

10. TABLE & CHAIRS

4. SOUND MODULE

An expandable, movable sound module might be provided for use in coordination with business and music programs, and may also serve as a private area for study or small meetings. The use of an independent module would provide an excellent space for acoustically isolating certain activities.

PHYSICAL CHARACTERISTICS

1. As specified.

SERVICE REQUIREMENTS

Electrical:

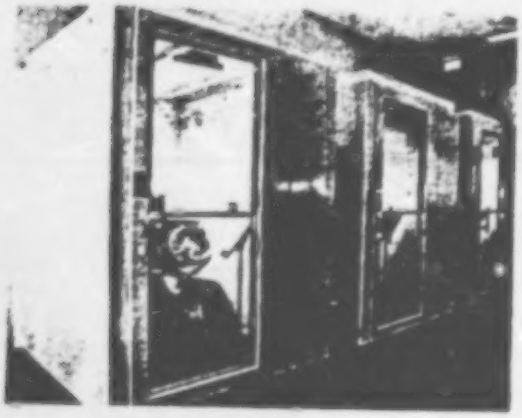
1. Power: Hook-up.

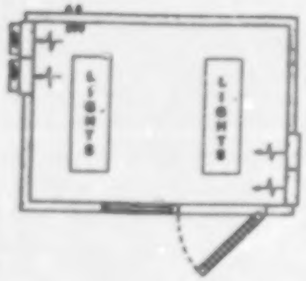
Mechanical:

1. Hook-up as specified.

CONCEPTUAL LAYOUT

SOUND MODULE





5. MULTIPURPOSE ROOM

The multipurpose room should be designed to accommodate a wide range of both school and community activities that will include:

1. Physical Education
2. General Assembly
3. Theater
4. Dancing
5. General Indoor Recreation
6. Community Meetings and Events
7. Food Service (Cafeteria)
8. Spectator Activities.

To gain additional multipurpose space in the 33-46 enrollment group, space for academic and resource programs might be added to the multipurpose room and planned for flexible use. A folding acoustic wall and athletic floor carpet might be provided to allow the space to function as a classroom and multipurpose room concurrently. This arrangement will require more effort for both the students and faculty to set up, but will provide the largest recreational space allowed within the DOE guidelines.

The multipurpose room should be located in close proximity to both locker room and toilet areas. Adequate equipment storage should be provided. This storage room might be designed to be the control point for administration and distribution of equipment for after-hours use. Special consideration should be given in the design phase to adequately plan for the storage of such items as wrestling mats, volleyball standards, and gymnastic equipment. This facility may be used by students and the community after school hours; therefore, to aid in after-hours administration, the facility should be designed to allow classroom areas and equipment to be secured while the multipurpose area is in use. If the facility is to be used jointly by elementary students while class is in session, access and acoustical separation should be provided to minimize disruption to the secondary school program.

PHYSICAL CHARACTERISTICS

Size:

1. 2,500 square feet (traditional program).
2. 4,000-5,000 square feet (adding classroom area to multipurpose room and providing acoustic separation).

Ceiling Height: 20 feet minimum.

Materials:

1. Walls: High light reflectance; acoustic; flush walls desirable.
2. Ceiling: High light reflectance; acoustic.
3. Floor: Maintainable; acoustic material depends on programmed usage.

Windows: Not recommended.

SERVICE REQUIREMENTS

Electrical:

1. Lighting:
   a. 50 FC; multilevel lighting through multiple switching.
   b. 70 FC in areas to be used for classroom.
   c. Guarded fixtures.
2. Power:
   a. Battery operated clock.
   b. Public address system.
   c. Miscellaneous outlets.

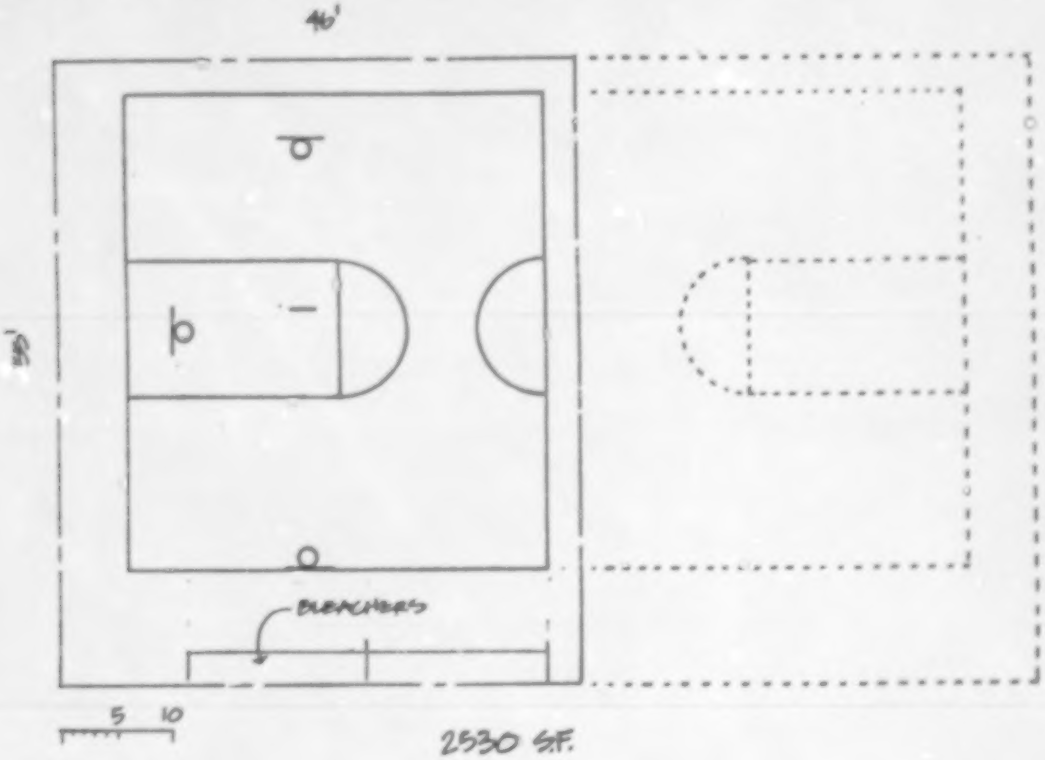
Mechanical:

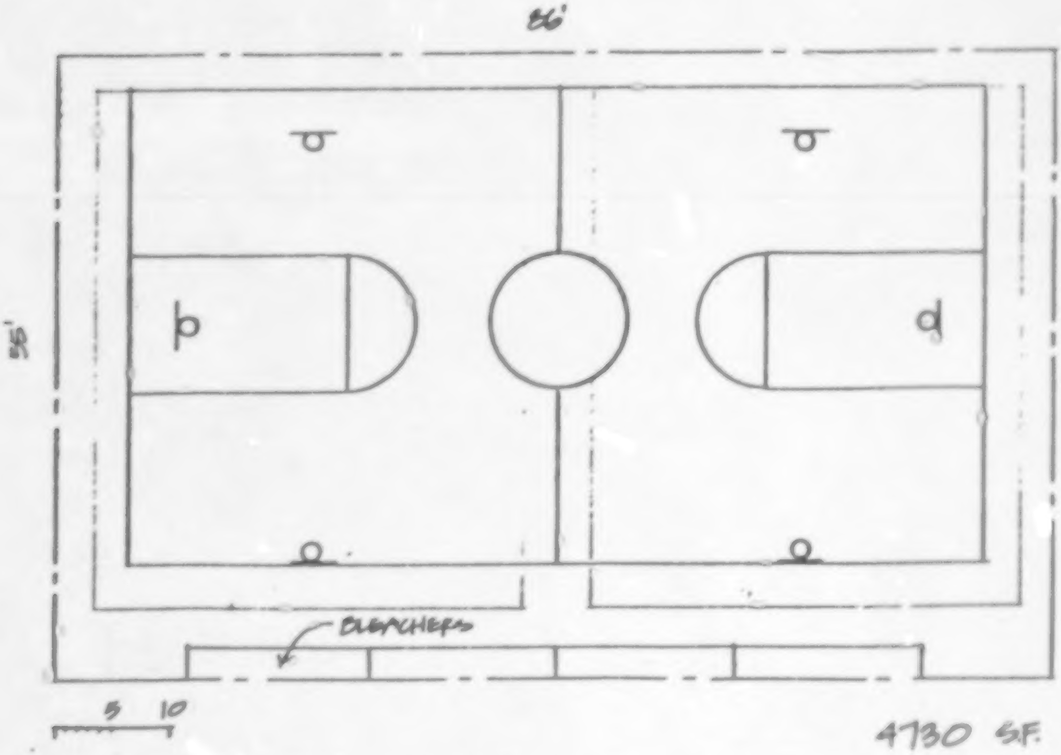
1. Heating: 60-72 degrees F.
2. Ventilation: As required for greatest use demands.
3. Plumbing: As required by classroom program.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Physical Education:

Item No.	Equipment List
a.	Tumbling mat (6 x 12 Ensolite) (4)
b.	Climbing rope (2)
c.	Weight set (2)
d.	Assortment of balls
e.	Basketball standards
f.	Volleyball standards
g.	Floor hockey equipment
h.	Wrestling mat
i.	Gym-scoots
j.	Balance beam
k.	Horse
l.	Badminton equipment
m.	Wiffle softball set
n.	Cones


46'
55'
BLEACHERS
5 10
2530 S.F.


86'
55'
BLEACHERS
5 10
4730 S.F.

6. SHOP

The Trades and Industries (T & I) program will be a program area of major interest in bush villages. The extent of the industrial education program in small high schools will be limited by the size of the facility, equipment, and fire code limitations. The thrust of the industrial education curriculum will be determined on a local and district level; the desired program space available and equipment layout must be closely coordinated with the designer to arrive at a realistic and functional arrangement. A Ken Cook Trans-national Learning Station will be utilized to supplement the desired program.

PHYSICAL CHARACTERISTICS

Size: 800 square feet.

Ceiling Height: 10-12 feet.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: High light reflectance; acoustic; fire resistant, as required.
2. Floors: Durable, nonabsorptive, nonskid (e.g., concrete topping is desirable; thin-set quarry tile or end grain wood is an alternate).
3. Ceiling: High light reflectance; acoustic.

Windows: 7'-6" minimum from floor, or eliminate.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC in work areas; guarded fixtures.
2. Power: 120/208-V., 3-phase; separate panelboard for industrial education power equipment with shunt trip main breaker or contactor controlled by emergency shutdown buttons.

Mechanical:

1. Heating: 67 degrees F. (to minimize injuries).
2. Ventilation: 5 CFM OSA/person, minimum. ASHRAE 62-73; plus special E/A requirements.
3. Woodshop: Sawdust collection requirements.

4. Metal Shop: Recirculating air purifier can be used for welding fumes.
5. Paint Finishing: Strict fire code requirements to be resolved in design.
6. Power Mechanics: Hazard area with special requirements.
7. Plumbing:
   a. Waste: Sand, grease, oil, solids interceptor; floor drains.
   b. Water: Sink with tempered water.

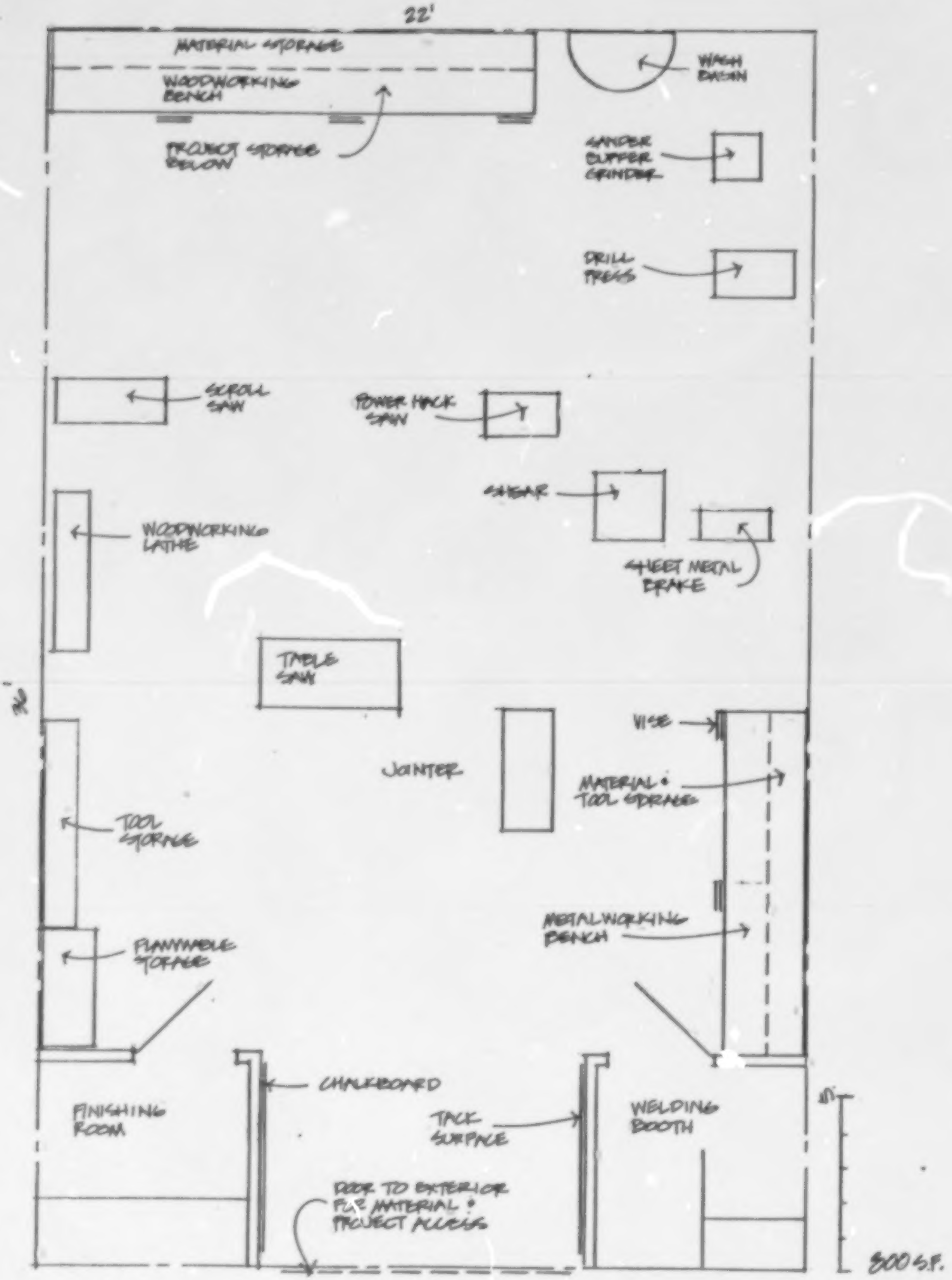
PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Industrial Education:

Item No.	Equipment List
a.	Chalk and tackboard
b.	4-student workbench (1)
c.	Drill press, 15" variable speed, w/1/2 HP motor (1)
d.	4" jointer w/1/3 HP motor (1)
e.	Table saw (1)
f.	Vise, machinist, swivel base, 5" jaw, opens to 6-1/2" (1)
g.	Builders saw, 7-1/4" (1)
h.	Bayonet saw kit (1)
i.	Belt sander, 3" x 21" (1)
j.	Disc sander, 7", 2/5/8 shaft (1)
k.	Drill, multispeed reversing, 1/2" (1)
l.	Drill, multispeed reversing, 1/4" (1)
m.	Miter box, 2/24 x 24" saw (1)
n.	Vise, woodworking, 4/10" jaw, open 12" (4)
o.	Tool storage cabinet (1)
p.	Ken Cook Trans-national Learning Station w/SR 100 A.V. desk (1)
q.	Assorted handbooks - both mechanics and woodworking (1)
r.	Power mechanics equipment (as programmed)
s.	Welding/metals equipment (as programmed)
t.	Finish booth
u.	Other equipment as program and space allow
v.	Material storage

Special Requirements:

1. Wash basin.
2. Dust exhaust systems.
3. Flammable liquid storage.
4. Fire code requirements for separation, use and storage of materials and equipment, and integration of T & I activities.
5. Acetelene and oxygen tanks for welding program should be stored on a movable cart and kept in a warm area. The performance of these gases for welding purposes is affected by extreme cold.
6. Exterior access for materials and projects (ramp, if above-grade).


22'
MATERIAL STORAGE
WOODWORKING BENCH
PROJECT STORAGE BELOW
WASH BASIN
SANDER BUFFER GRINDER
DRILL PRESS
SCROLL SAW
POWER HACK SAW
SHEAR
SHEET METAL BRAKE
WOODWORKING LATHE
TABLE SAW
36'
VISE
JOINTER
MATERIAL & TOOL STORAGE
TOOL STORAGE
METALWORKING BENCH
FLAMMABLE STORAGE
CHALKBOARD
FINISHING ROOM
TACK SURFACE
WELDING BOOTH
DOOR TO EXTERIOR FOR MATERIAL & PROJECT ACCESS
800 S.F.

7. TEACHER OFFICE AREA/ADMINISTRATION

The teacher in the small school is a person of many responsibilities and functions. Teacher office areas must be accessible to students and allow for maximum area observation. Secure storage for student records and funds, and space for the school radio or CB must be provided. A multiuse room might be provided that would serve as a teacher prep area, administrative office, and audio-visual storage.

PHYSICAL CHARACTERISTICS

Ceiling Height: 8 feet minimum.

Materials: (Quality)

1. Walls: Acoustic.
2. Ceiling: Acoustic.
3. Floor: Acoustic.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 70 FC in work areas.
2. Power:
   a. Miscellaneous outlets.
   b. Radio, TV antennae, telephone.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Administration:

Item No.	Equipment List
a.	Desk and chair (4)
b.	4-drawer file cabinet with lock (4)
c.	Bookshelves
d.	Small conference table (optional)
e.	Secure storage for student records and money
f.	Telephone/radio/CB
g.	Typewriter and stand
h.	Coffee Pot

Special Requirements:

1. Power strip.
2. Task lighting.

SUPPLEMENTARY SPACE

8. TOILETS

The level of feasible service will be determined on a site-specific basis. Actual fixture counts will vary due to code interpretations, enrollment, utilization of facility, village population, and availability of water. In determining the number of fixtures required, consider the possibility of increased enrollment and community use. The following are facility recommendations for the 33-46 student enrollment group:

	Men		Women
Water Closets	2		2
Urinals	2		
Lavatories	2		2
Showers	3		3
Drinking Fountain		1	

PHYSICAL CHARACTERISTICS

Ceiling Height: 7.5 feet minimum.

Materials: (Quality)

1. Walls: Water resistant; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Water and wear resistant.

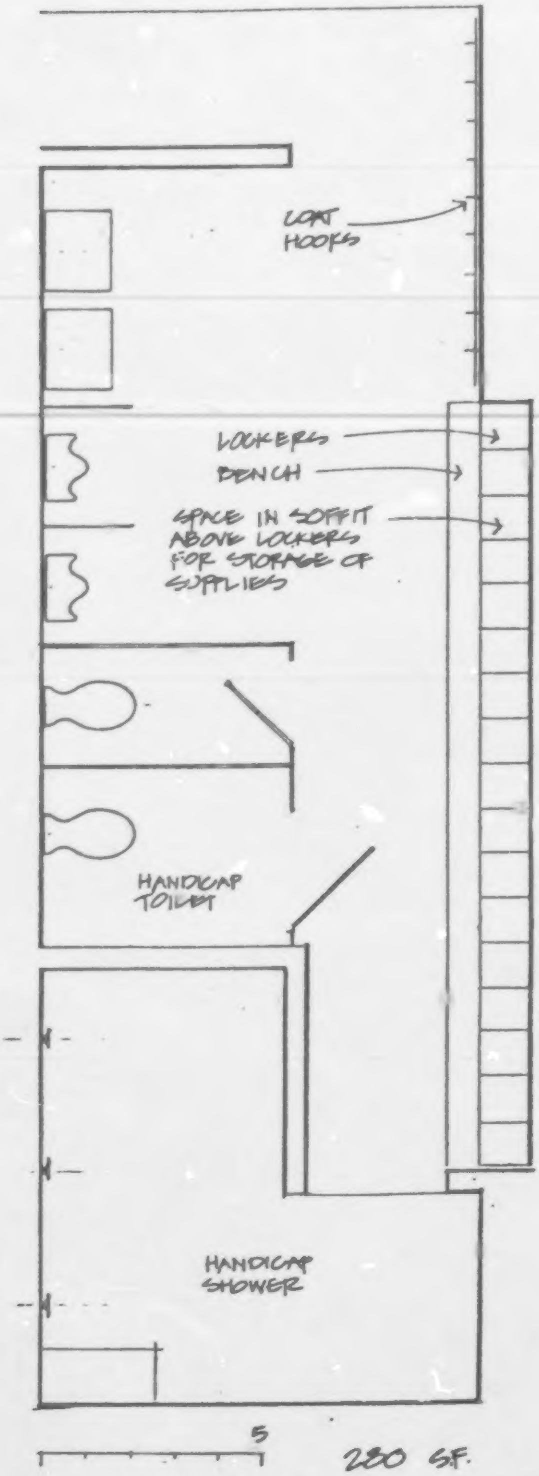
SERVICE REQUIREMENTS

Electrical:

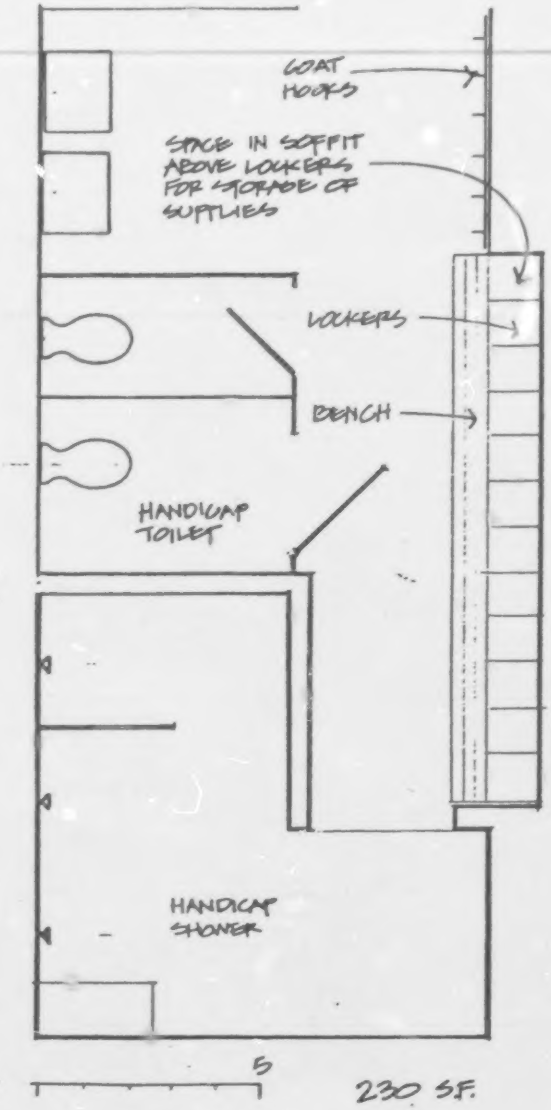
1. Lighting: 30 FC; vapor-tight and vandalproof fixtures.
2. Power: Outlets ground fault protected.

Mechanical:

1. Heating: 70-75 degrees F.
2. Plumbing (site-specific):
   a. Water - tempered.
3. Exhaust air.


COAT HOOKS
LOCKERS
BENCH
SPACE IN SOFFIT ABOVE LOCKERS FOR STORAGE OF SUPPLIES
HANDICAP TOILET
HANDICAP SHOWER
5
230 S.F.

MENS TOILET


COAT HOOKS
SPACE IN SOFFIT ABOVE LOCKERS FOR STORAGE OF SUPPLIES
LOCKERS
BENCH
HANDICAP TOILET
HANDICAP SHOWER
5
230 S.F.

WOMENS TOILET

SUPPLEMENTARY SPACE

9. MECHANICAL/ELECTRICAL AREAS

The mechanical room and electrical panel should be located on the main level and be easily accessible and close to an entry (not on an upper level or in an attic space).

The pending freeze-up danger and the unavailability of a local repair service with a spare parts inventory, increase the need for a well planned mechanical/electrical room. It is very important to provide enough room in this space to easily service all equipment. Too often in the early stages of design, this area is established by the architect without adequate consultation with the mechanical and electrical engineers. The failure of one of these systems, and an inability to have ready access for diagnosis and repair, can result in serious damage to the facility and its contents and loss of a school program. However, the room should be planned not to have more space than is needed for equipment servicing (including major replacement); too much space will result in unauthorized storage of materials in this room (a code violation). Doors, knock-out panels, or some means of egress for the largest piece of equipment must be provided for future replacement. The electrical and control panels should be located so that the net clear space (minimum 30 inches by code) in front of them must be used for circulation space within the mechanical room. This helps to prevent the storage of materials in front of the panels (panels may be located elsewhere in the building with these guidelines applied).

PHYSICAL CHARACTERISTICS

Size: 13'-6" x 7' minimum (will vary with equipment used).

Ceiling Height: 9 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 808.

1. Walls: High light reflectance; washable.
2. Ceiling: High light reflectance; washable.
3. Floor: Combustible or noncombustible surface depending on fuel-fired equipment specified; noncombustible recommended to reduce fire hazard of absorbed fuel oil.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 20 FC.
2. Power: Two outlets; ground fault protected (minimum).

Mechanical:

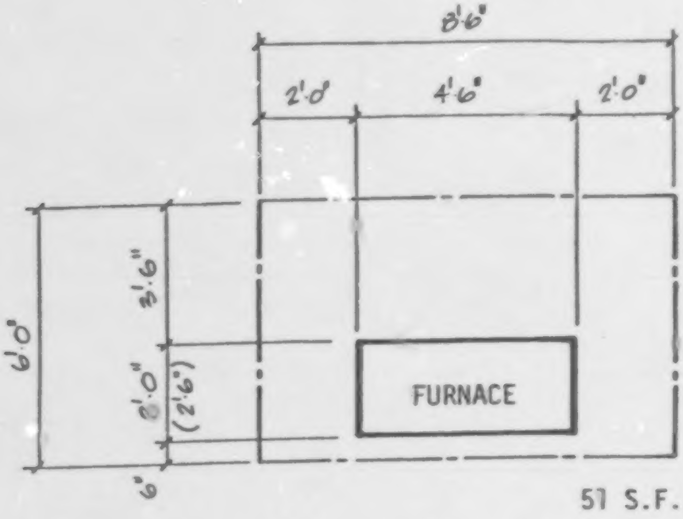
1. Fuel supply and day tank.
2. Hot water heater.
3. Boiler.
4. Furnace.
5. Space for hot water circulating pumps and piping.
6. Space for glycol mixing drum (55 gallon).
7. Space for chimney(s).

CONCEPTUAL LAYOUT MECHANICAL/ELECTRICAL AREAS

Building Size: 8,800 S.F.

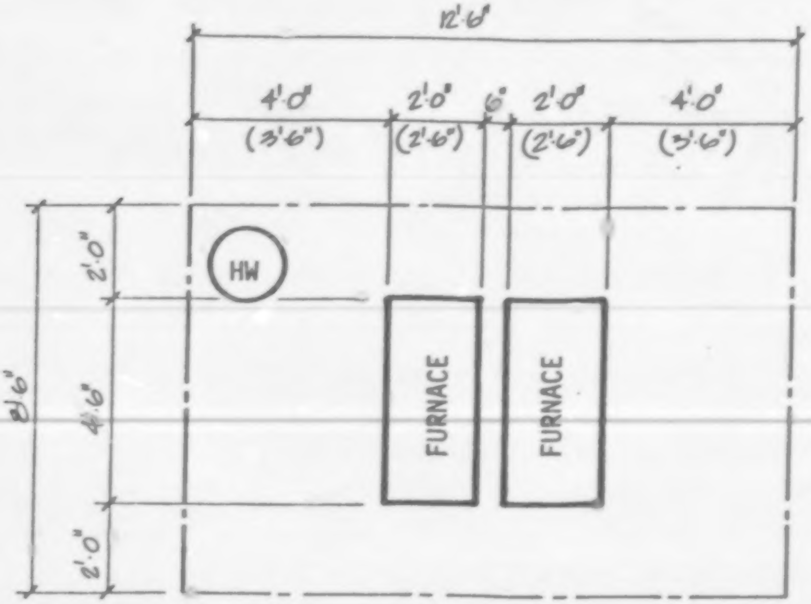
Note:

1. Heating load assumed to be 300,000 BTU/HR.
2. A simple "pot-type" oil-burning stove should be installed, centrally located to heat entire building under emergency conditions.
3. Hot Water Heater: Electric, 2 KW.

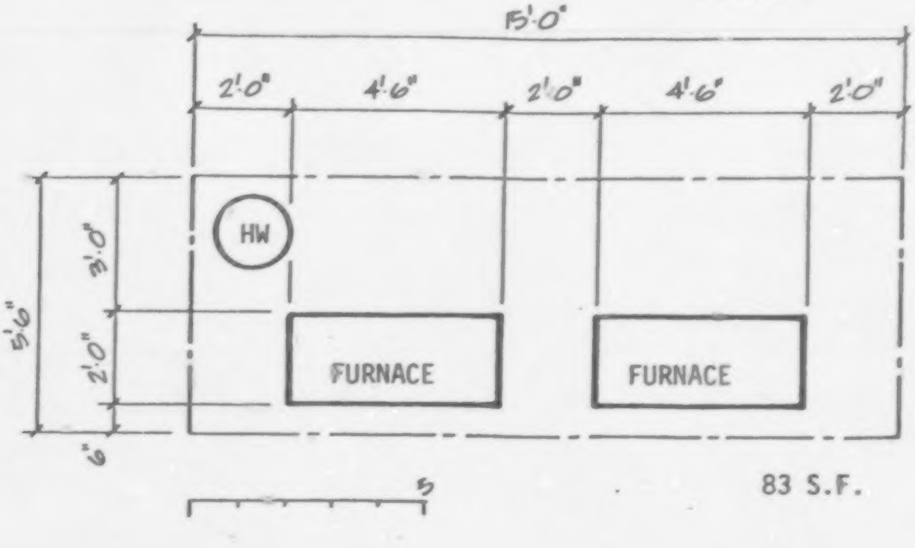


(1) Furnace (No Standby):

BTU Each Furnace:	300,000
Furnace Dimensions:	30" x 55"
Furnace Room Dimensions:	6'-0 x 8'-6'


12'-6"
4'-0"
(3'-6")
2'-0"
(2'-6")
6"
2'-0"
(2'-6")
4'-0"
(3'-6")
8'-6"
2'-0"
4'-6"
2'-0"
HW
FURNACE
FURNACE

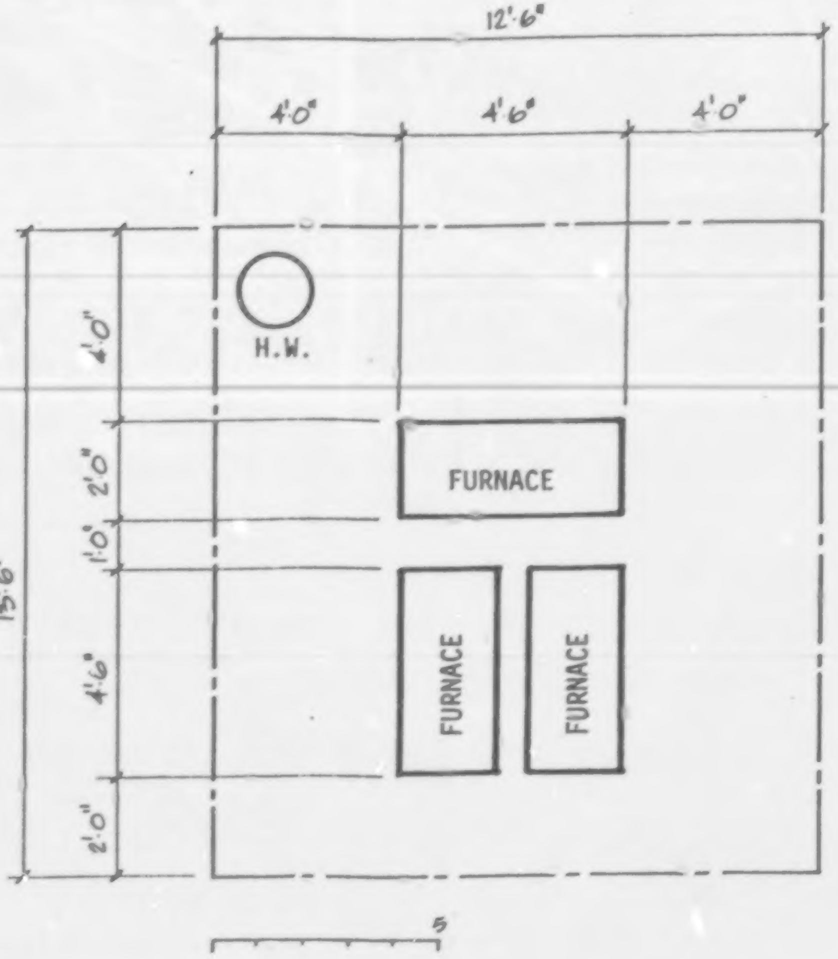
100 S.F.


15'-0"
2'-0"
4'-6"
2'-0"
4'-6"
2'-0"
5'-6"
3'-0"
2'-0"
6"
HW
FURNACE
FURNACE
5

83 S.F.

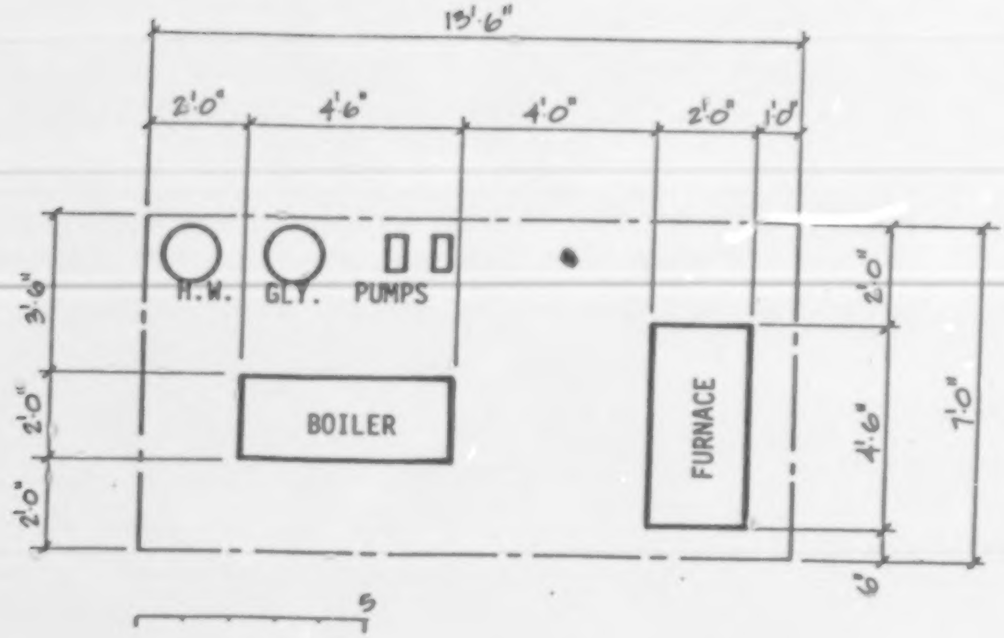
(2) Furnaces (75% of Full Load Each):

BTU Each Furnace:	200,000
Furnace Dimensions:	30" x 40"
Furnace Room Dimensions:	8'-6" x 12'-6"


12'-6"
4'-0"
4'-6"
4'-0"
13'-6"
4'-0"
2'-0"
1'-0"
4'-6"
2'-0"
H.W.
FURNACE
FURNACE
FURNACE
5

(3) Furnaces (50% of Full Load Each):

BTU Each Furnace:	110,000
Furnace Dimensions:	24" x 54"
Furnace Room Dimensions:	12'-6" x 13'-6"


13'-6"
2'0"
4'6"
4'0"
2'0"
1'0"
H.W.
GLY.
PUMPS
BOILER
FURNACE
3'6"
2'0"
2'0"
2'0"
4'6"
7'0"
6"
5

(1) Furnace plus (1) Boiler:

BTU Each Furnace:	150,000
CFM	± 1,600
Furnace Dimensions:	30" x 40"
Boiler Size:	22" x 52"
Mechanical Room Dim.:	13'-6" x 7'-0"

SUPPLEMENTARY SPACE — 10. MAINTENANCE ROOM

The maintenance room is provided within the small rural high school as a space for building repair, daily cleaning, and storage. It is required by building code that this space not be part of the fuel-fired equipment room. The workbench and storage shelving should be carefully planned and built-in to prevent this space from being used for unauthorized purposes. This room must be large enough to house all cleaning equipment (vacuum, mops, ladder, cart, brooms, etc.), a minimum quantity of cleaning supplies and products, a mop sink, a workbench (30" x 60"), and storage for tools, manuals, maintenance records, and spare parts. This space must be well lighted, accessible, and adequately sized to meet the needs of the local maintenance program requirements. Usually the maintenance room will be located on a plumbing wall adjacent to the toilet areas to minimize plumbing runs.

PHYSICAL CHARACTERISTICS

Size: 76 square feet minimum.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Construction; see UBC, Section 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: General 30 FC, and 70 FC for task lighting over workbench.
2. Power: Three outlets; ground fault protected (one at workbench height).

Mechanical:

1. Plumbing: (Site-specific).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Maintenance:

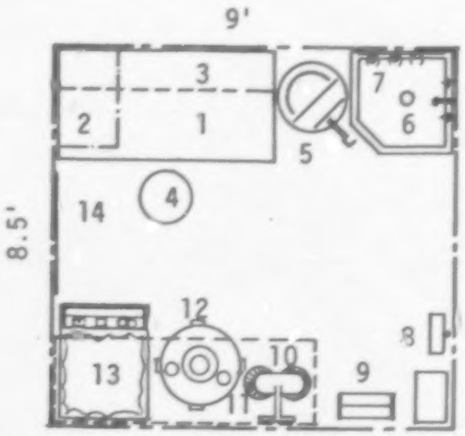
Item No.	Equipment List
a.	Mop sink
b.	Mop rack
c.	Shelving (above and below workbench)
d.	Vacuum cleaner, hose, and attachments
e.	Janitorial cart (optional)
f.	Ladder
g.	Miscellaneous cleaning supplies (gallon containers)
h.	Miscellaneous paper products (2 weeks supply)
i.	Building maintenance tools
j.	Large push broom
k.	Large push dustmop
l.	Snow shovel, ice chipping tool
m.	Wet mops
n.	Mop bucket with wheels and wringer
o.	Vise
p.	Tool box
q.	2-drawer file cabinet

Special Requirements:

1. Workbench with metal surface.

CONCEPTUAL LAYOUT MAINTENANCE ROOM

1. WORK BENCH W/METAL SURFACE
2. 2 DRAWER FILE CABINET
3. TOOL & PARTS STORAGE
4. STOOL
5. MOP BUCKET
6. MOP SINK
7. MOP & BROOM RACKS
8. SHOVEL & MISCELLANEOUS BUILDING MAINTENNANCE TOOLS
9. STEP LADDER
10. FLOOR CLEANER
11. PAPER & CLEANING SUPPLY STORAGE
12. VACUUM CLEANER
13. JANITORIAL CART
14. PORTABLE SCAFFOLD



76 SF

SUPPLEMENTARY SPACE 11. CIRCULATION

The defined circulation space in the facility for 33-46 students will vary according to whether the design is an open or traditional plan. In an open-plan concept, actual circulation space exists, but is calculated as a part of the assignable classroom area. Efficiency calculations of assignable and unassignable space may be misleading. In either case, circulation paths should avoid dissecting a program area and should instead be used to emphasize teaching stations and minimize disruptions. The corridor may be used as an acoustic buffer between quiet and noise producing areas, e.g., between multipurpose and academic areas, but may also act as a conductor of unwanted sound from noisy to quiet space. The corridor may also be utilized as a distribution spine for utilities, i.e., plumbing overhead and waste below the floor.

The minimizing of the total space devoted to circulation should be a design goal. In determining the widths of exit corridors, the design should include an occupant load based upon use of the multipurpose room by the entire community.

The design of circulation space as an exit corridor will need to comply with the State Fire Marshal's current code interpretations if an alcove off this space is to be used for storage of students' coats and books. [1] Handicap maneuverability, clearance, and surface finish requirements must be taken into consideration when designing circulation paths.

PHYSICAL CHARACTERISTICS

Width: Exit Corridors - 6 feet minimum.

Ceiling Height: 8 feet minimum.

Material: (Quality). Exit Corridors - see UBC, Section 3304(g).

1. Walls: Durable, readily cleanable; moderate light reflectance.
2. Floors: Acoustic; color should mask effects of soiling. (At Entries: absorptive and/or readily cleanable and water resistant surfaces).
3. Ceiling: Durable; acoustic.

Windows: Desirable to provide psychological relief.

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[1] Taken from Minutes of Meeting on 6/30/78 with State Fire Marshal. Subject to reinterpretation by State Fire Marshal's office; reader to confirm details.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: Variable 20-30 FC, general area. Increased lighting in display and planting areas.
2. Power: Miscellaneous outlets.

Mechanical:

1. Heating: 70 degrees F.
2. Drinking Fountain: Where applicable (per handicap requirements).

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Student coat and book storage
b.	Display cabinets (optional)
c.	Seating (optional)
d.	Tack surfaces

SUPPLEMENTARY SPACE — 12. GENERAL STORAGE

Adequate storage specifications will be site-specific. Each particular school district must develop specifications according to its purchasing-stocking-shipping requirements and the specific logistics of each site. One option for cold storage is to provide a more cheaply constructed, separate, unheated storage building on the school site. Often, existing structures can be cheaply modified for storage use. A creative custodian and school staff can maximize storage space if unneeded items are disposed of and material inventories are carefully monitored (one small school was found annually ordering envelopes without realizing they had an 80 year supply). Suggestions that help assure that the storage room is used as programmed include shelving installed at construction, a minimum of circulation space, minimum electrical outlets, and utilization of odd shaped "left-over" areas. Long-term storage can be provided in attics and mezzanines when provided with access that is convenient and heavy enough for carrying the supplies to the space; however, all storage rooms must be One-hour Fire-resistive Construction. If the storage room is located on the second level, the State Fire Marshal is currently classifying the facility as a 2-story structure due to the potential of the storage room being used as a classroom. (See Section 5.40).

Three separate storage areas are needed for each school to provide for:

1. Plant Support Materials: Toilet paper, extra pipe, spare parts, cleaning supplies, oil, etc.
2. General Instructional Supplies: Books, paper, audio-visual equipment, etc.
3. Food Storage: (Food must be stored on shelves or pallets above the floor, and food must not be stored in classrooms or the boiler room).

PHYSICAL CHARACTERISTICS

Size: (site-specific).

1. Plant Support Materials: 120 square feet.
2. General Instructional Supplies: 120 square feet.
3. Food Storage: 126 square feet; Class "A" lunch program.

Ceiling Height: Varies (if less than 6'-6", this can be considered "bonus" space according to DOT/PF Design Standards for Space Utilization).

Materials: One-hour Fire-resistive Construction Per UBC 802(c). (See also Section 5.38).

1. Walls: High light reflectance; washable.
2. Floors: Washable; durable.
3. Ceiling: High light reflectance.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Varies (use minimum required).

Mechanical:

1. Heated or Unheated: Varies (site-specific).
   - a. Plant Support Materials: Above 32 degrees F.
   - b. Food Storage: Cold - 0 degrees F.; Dry Goods - 60 degrees F. or below.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Item No.	Equipment List
a.	Industrial grade adjustable shelving w/12" wide shelves.

SUPPLEMENTARY SPACE 13. FOOD SERVICE

The food service program for a secondary school of 33-46 students will depend on several factors:

1. Local village priority for food service program versus other programs.
2. Ability of secondary school to share use of food service program at elementary school, or in the other instance, the need to provide for a combined food service program as a part of the secondary school.
3. Type and extent of food service program to be offered by the school district.

The food service program is a major operational expenditure. To reduce operating costs, some districts are switching their program from the traditional hot lunch to a program where frozen dinners are heated in convection ovens and served to the students with disposable dishes and utensils. This not only cuts down on the cost per meal, but also reduces the need for an elaborate kitchen, minimizes staffing, and allows more space and budget to be devoted to operating the educational program. In some villages, this frozen dinner program may not be popular if it causes a reduction in local employment.

The frozen dinner program does not need a separate kitchen and may utilize home science equipment provided in the lab area. However, if the food service program is to be included as a part of the lab area, then the layout of this area must be worked out with the approval of the Environmental Health Section of the Division of Public Health. If proper sanitizing for dishwashing is unavailable, disposable dishes and utensils must be used for the food service program as well as for home science. If the lab is utilized for this type of food service program, additional space must be provided for the storage of dry goods, frozen goods, and paper products, depending on frequency of delivery. It may also be desirable to specify a commercial convection oven.

Government subsidies are available to districts to help defray the cost of the food service program as long as the program complies with Federal standards. Subsidies, local employment, and demand may keep the traditional hot lunch program as a feasible program in many districts; in this case, additional space must be programmed into a facility to accommodate food preparation and dry and cold storage.

GENERAL GUIDE FOR FREEZER SPACE

	NUMBER OF LUNCHES SERVED DAILY		
Delivery Intervals	25-100	100-300	300-500
Monthly	50 cu. ft. (reach-in or upright)	132 cu. ft. (8 x 10')	560 cu. ft. (8 x 10') walk-in
3 Months	132 cu. ft.	560 cu. ft. 80 sq. ft. (8 x 10')	672 cu. ft. 96 sq. ft. (8 x 12')
6 Months	560 cu. ft. (80 sq. ft.)	672 cu. ft. (96 sq. ft.)	1120 cu. ft. (160 sq. ft.)

Figures are based on 30 lbs. storage per cu. foot.

PHYSICAL CHARACTERISTICS

Size: 650 s.f. minimum.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Section 802(d).

1. Walls: Washable finish.
2. Floor: Washable.
3. Ceiling: Washable.
4. Base: Coved, washable.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC general area; 70 FC task lighting; vapor-tight fixtures.
2. Power: 120/208-V., 3-phase; load varies with equipment.

Mechanical:

1. Heating: 65 degrees F.
2. Ventilation: Use range hood; draw make-up air from adjacent areas.
3. Plumbing:
    a. Waste: Sink requires grease trap which presents problems with or without this unit.
    b. Water: Hot and cold. Sanitizing water (140 degrees F.) required if washing dishes or utensils.

PROGRAM EQUIPMENT LIST AND SPECIAL REQUIREMENTS

Frozen Dinner Program:

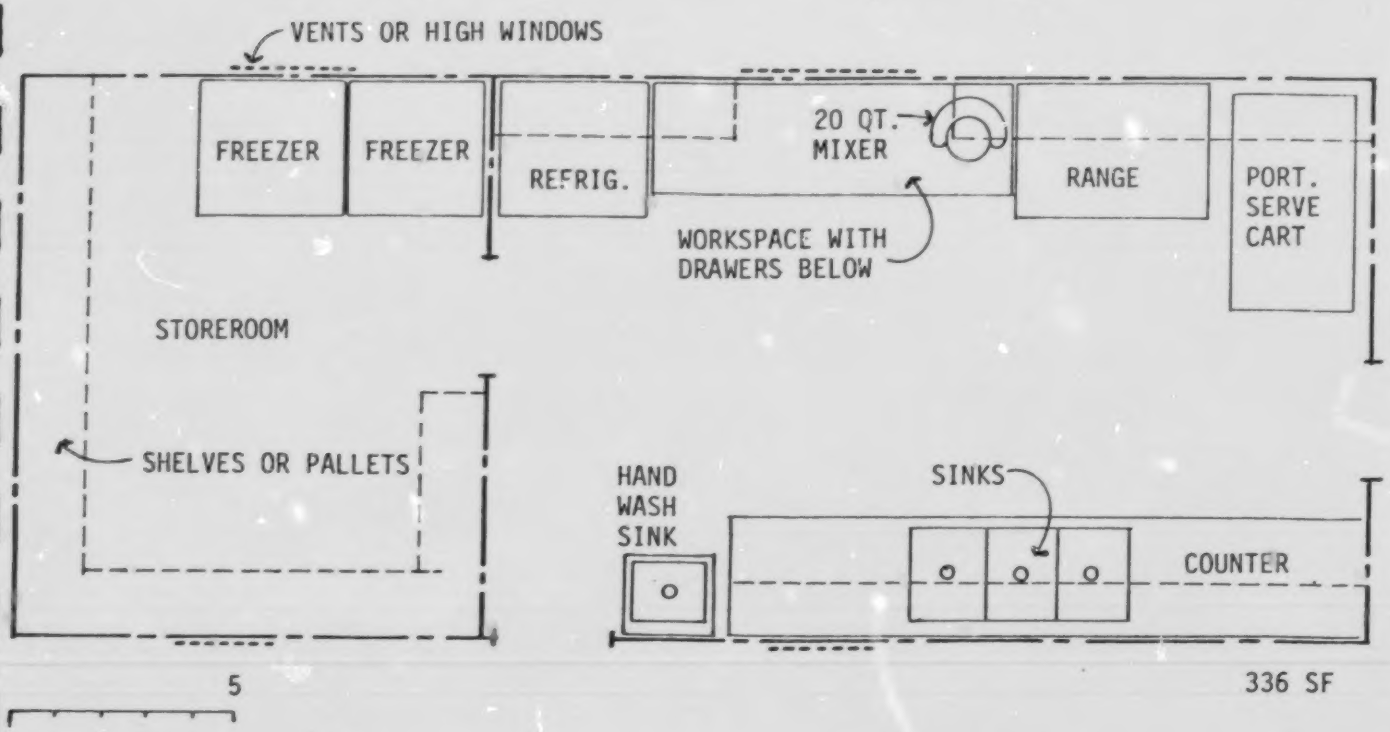
Item No.	Equipment List
a.	Convection oven
b.	Sink
c.	Disposable dishes and utensil storage
d.	Dry goods storage
e.	Frozen goods storage
f.	Refrigerator
g.	Exhaust hood

Traditional Hot Lunch:

Item No.	Equipment List
a.	Range with oven, 36" (1)
b.	Oven, convection (1)
c.	Stock pots (varies)
d.	Mixer with attachments (1-20 qt.)
e.	Dishwasher or 3-compartment sink with drainboard
f.	Handwash sink
g.	Refrigerator
h.	Freezer
i.	Cooks table with drawers and rack
j.	Pot and pan storage rack
k.	Exhaust hood
l.	Utility cart, 3-shelf
m.	Fire extinguisher
n.	Microwave oven
o.	Student seating tables and storage

Special Requirements:

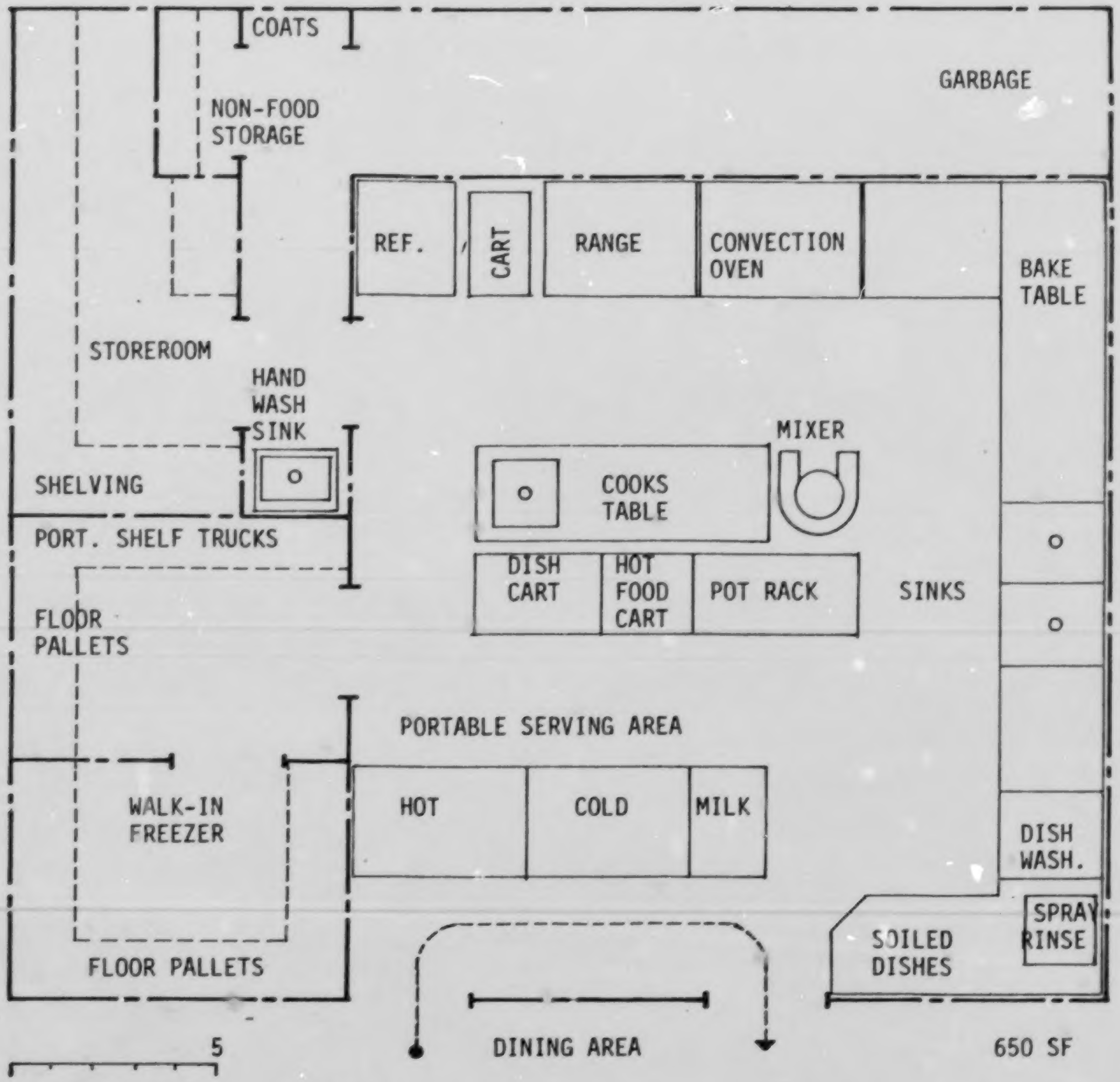
1. Propane won't flow in extreme cold. Tanks must be stored in warm area.


VENTS OR HIGH WINDOWS
FREEZER
FREEZER
REFRIG.
20 QT. MIXER
RANGE
PORT. SERVE CART
WORKSPACE WITH DRAWERS BELOW
STOREROOM
SHELVES OR PALLETS
HAND WASH SINK
SINKS
COUNTER
5

336 SF

Plan developed by Amelia E. Snell, R.D.
Furnished by DOE

KITCHEN - SERVING UNDER 25 STUDENTS


COATS
GARBAGE
NON-FOOD STORAGE
REF.
CART
RANGE
CONVECTION OVEN
BAKE TABLE
STOREROOM
HAND WASH SINK
MIXER
SHELVING
COOKS TABLE
PORT. SHELF TRUCKS
DISH CART
HOT FOOD CART
POT RACK
SINKS
FLOOR PALLETS
PORTABLE SERVING AREA
WALK-IN FREEZER
HOT
COLD
MILK
DISH WASH.
SPRAY RINSE
SOILED DISHES
FLOOR PALLETS
5
DINING AREA
650 SF

Plan developed by Amelia E. Snell, R.D.
Furnished by DOE

KITCHEN - SERVING 25-100 STUDENTS

SUPPLEMENTARY SPACE 14. ON-SITE GENERATION

Some level of on-site electrical generation will be required at nearly every site. Size, type, and number of generating units will vary according to the size of the school and the availability, reliability, and cost of commercial power (see discussion in Section 9.42, Building Utilities). Levels of on-site generation will be divided into three general categories:

> Level One; Minimum Standby: On-site generation of minimum capacity required to keep essential systems operating to prevent damage to the school during commercial power outages. Unit is sized to power a few lights and building heating equipment. Use of the school would not be possible while on standby power. This level of on-site generation would be applicable to those sites having reasonably reliable commercial power systems where power outages would be expected to occur infrequently and be of short duration.
>
> Level Two; Full Standby: On-site generation with sufficient capacity to allow normal operation of the school during loss of commercial power. Standby generation would be provided by a single unit sized to accommodate the full load requirement of the school. This level of on-site generation would apply where outages of several days' duration can be expected.
>
> Level Three; 100% On-Site Generation: On-site generation to provide 100 percent of the school's electrical energy would consist of two generating units sized to accommodate the school's full load requirements, plus one smaller generating unit for night and weekend loads. This level of on-site generation would apply where commercial power is unavailable, too unreliable, or too costly to be used.

Space requirements for any level of on-site generation must allow easy access to both sides and rear (generator end) of each generating unit for maintenance and repair. Space must also be provided for proper clearance in front of switchgear, and for working clearance around any auxiliary equipment. For Level Three generation, workbench space should be provided, in addition to the workbench space provided in the school maintenance room.

Space for Level One generation might be provided within the school building itself. As an alternative, Level One generation could be provided by a portable, air-cooled, fully enclosed unit which is moved from storage into place outside the school and plugged into an exterior connection when needed.

Level Two and Three generation should be installed in a building separated from the school and all other buildings by at least 20 feet for fire and noise reasons.

PHYSICAL CHARACTERISTICS

Size: Varies with level of on-site generation and physical size of generating units:

Level One: 120 square feet.
Level Two: 168 square feet.
Level Three: 350 square feet.

Ceiling Height: 8 feet minimum.

Materials: One-hour Fire-resistive Occupancy Separation per UBC, Table 5-B.

1. Walls: Taped gypsum board.
2. Ceiling: Taped gypsum board.
3. Floor: Nonabsorptive, nonslip (metal with abrasive finish; light weight concrete).

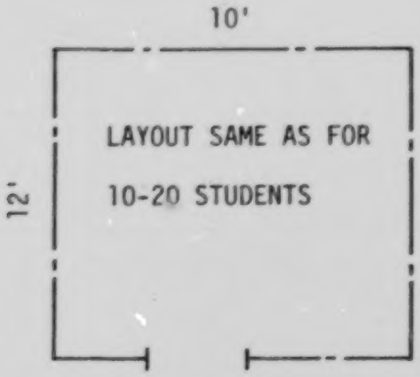
SERVICE REQUIREMENTS

Electrical:

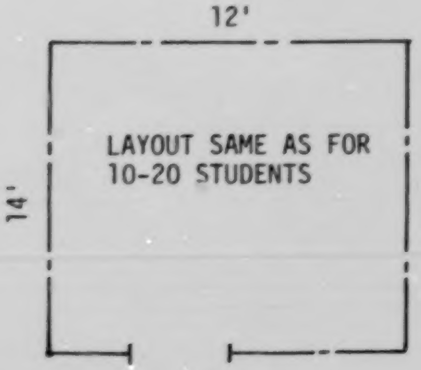
1. Power: Convenience outlets located around perimeter of generator building, approximately 10 feet on center. Convenience outlets over workbench. Power for jacket water tank heater.
2. Lighting: 20-30 FC, general lighting; 70 FC task lighting over bench.

Mechanical:

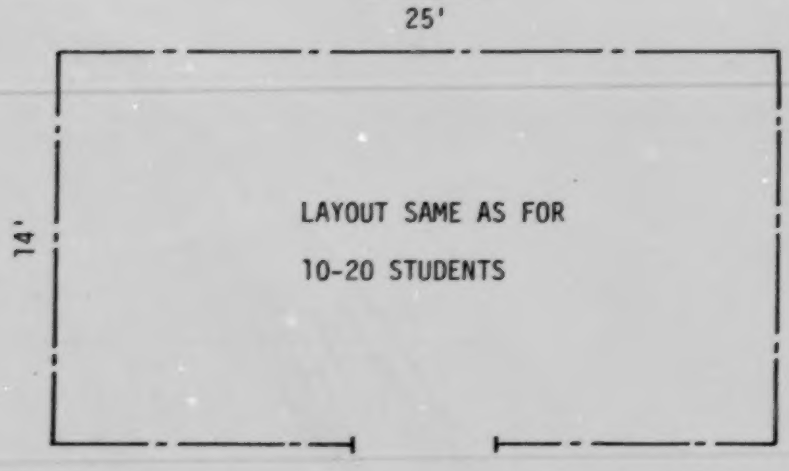
1. Fuel supply.
2. Cooling air for generator and jacket water, combustion air for engine.
3. Waste heat equipment (Level Three).
4. Fire Suppression: Halon or CO2 system.


10'
12'
LAYOUT SAME AS FOR
10-20 STUDENTS

LEVEL ONE


12'
14'
LAYOUT SAME AS FOR
10-20 STUDENTS

LEVEL TWO


25'
14'
LAYOUT SAME AS FOR
10-20 STUDENTS

LEVEL THREE

SUPPLEMENTARY SPACE 15. WATER UTILITY

For those villages with central piped distribution systems, space allocation for water service should take no floor space unless a small recirculation pump is required. In case of the latter, provision for access to the pump for periodic maintenance should be provided. (See Section 6.1 for water system options, and Section 3.1 for water system determinants).

For newly developed school sources, space allocation for water utility pressurization, treatment, and pumping will be necessary. The location of a water utility area should be on the main floor and easily accessible. Daily monitoring of treatment is necessary. If located on an upper level, access shall be by a full-sized stairway. Space set aside for storage of chemicals and replacement/repair of mechanical equipment should be analyzed by the architect. Many villages have annual delivery service only by barge, and high air freight delivery costs should be compared to the initial cost of providing annual storage space for items needed to maintain the water utility.

Protection from freezing is mandatory. Failure of the water system may not stop operation of the teaching program, but will result in loss of capital investment as well as providing a hardship. The occurrence of communicable disease is high in those villages without a central system; often, the villagers look to the school as the only safe potable water supply.

Design of the system for a maximum six-year projected enrollment will allow for reasonable future expansion. A minimum of 25 gallons per person per day is a recommended minimum where water sources availability permits.

Use of storage tanks as a wintertime supply will require additional space for heating for equipment that provides freeze protection. Sizing of the tank should be based on the longest expected freezing time of the source, with an additional buffer for concentration of contaminants at the bottom of the tank.

Connection of the water supply to the building should take the differential movement of each into consideration. Use of insulated flexible connections is recommended.

Additional treatment of water may be required for schools where the water source is high in turbidity, color, iron, etc. Physical-chemical treatment requires vessels with flow rates of approximately three gallons per minute per square foot of area. This additional treatment should probably occur in a separate building or in an area that is nonaccessible to the public.

PHYSICAL CHARACTERISTICS

Size: Varies with equipment used. Minimum 36 square feet.

Ceiling Height: 7.5 feet minimum.

Materials:

1. Walls: High light reflectance, washable. Chemical resistance in storage areas.
2. Ceiling: High light reflectance, washable.
3. Floors: Impermeable, noncombustible depending on heating equipment used for equipment room or storage tanks.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: Two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Heating: Above freezing.
2. Plumbing: site-specific.
3. Supplementary fuel supply.
4. Chlorination system.
5. Filtration system (pressure filter, rapid sand filter).

Optional:

6. Aeration tower.
7. Flocculation chamber.
8. Ion-exchange filters.
9. Permanganate green sand filters.
10. Fluoridation system.

SUPPLEMENTARY SPACE

16. WASTE WATER DISPOSAL

Connection of the building sewer line to an existing sewer system should take no additional space when a gravity sewer service line is used. If a pump is necessary to move the sewage into the existing utility, then a sump may be required at some point in the building, probably below floor elevation. Sump pumps may also be required for moving sewage to a treatment plant or septic tank. Sumps could be located with easy and complete access through the floor from "supplemental" space above. The enclosure for sumps must be very well insulated with nonmoisture susceptible insulation; additional heat may be needed here as it is at a low elevation within the building.

Septic tanks are usually installed outside the building and underground; thus, they would require no space within the building. Other similar alternatives such as a lagoon or pond disposal would require no building space other than a possible sump pump as stated above.

Nonwater-borne waste disposal as found in chemical, humus, or incinerating toilets, may need additional space to allow proper handling of wastes such as holding tanks and "honey buckets". Special access to such toilets may be desirable from an esthetic point of view. Methods of collecting such waste may dictate location in the building.

When a sewage treatment plant within the building is deemed the best solution, additional storage space will be required for chemicals used in treatment. The frequency of delivery of such chemicals will dictate the amount of storage required.

Capacity for future expansion can be adequately handled by designing for a projected enrollment as discussed in Section 6.2. The size of the treatment plant listed below is based on 15 gallons per capita per day for schools without multipurpose rooms and showers and 25 gallons per capita per day for schools with multipurpose rooms and showers.

PHYSICAL CHARACTERISTICS

Size: Equipment would occupy about 8' x 8'. Added clearance for maintenance would bring the total area to 150 square feet.

Ceiling Height: Depends on type of unit. If pumps must be lifted above tanks for maintenance and repair, ceiling height may need to be as much as 15 feet.

Materials:

1. Walls: Good light reflectance, washable, chemical resistant.
2. Ceilings: Same as walls.
3. Floors: Impermeable, sloped to drain with emergency overflow provisions.

SERVICE REQUIREMENTS

Electrical:

1. Lighting: 30 FC.
2. Power: To handle up to 2.5 HP., two outlets, ground fault protected.
3. Alarm Panel: Audio and visual.

Mechanical:

1. Temperature: Above freezing.
2. Plumbing: To handle flows.
3. Heating: Separate from rest of building.
4. Ventilation: Separate from rest of building.
5. Chlorination: Usually in tablet form; no power required.

General: Space requirements for packaged sewage treatment plants will vary with models available. Sizes are not standardized. Different methods of treatment would dictate size also. "Batch" treatment requires waste water storage at beginning of process, which may increase the space requirement. Sizes of packaged treatment plants are usually supplied in increment sizes that would accommodate more than one size of school.

SECONDARY SCHOOL
33-46 STUDENTS

4.44 DOE SECONDARY SCHOOL SPACE GUIDELINES

SPACE SUMMARY:

Student Enrollment	33-46
Classroom(s)	1,500 1/
Library/Media Center (% of Individual Study Space)	1,100 65%
Science Classroom	800
Office	-0-
Business Education	100
Home Science	-0-
Industrial Education	800
Multipurpose Space	2,500
Supplementary Space	2,000 (23% of Gross)
Restrooms Storage Hallways Wall Thickness Kitchens Mechanical Space	
TOTAL	8,800 S.F.

1/ Includes wet area for Home Economics.

5.0 Building Safety Options

SECTION CONTENTS

5.0 BUILDING SAFETY AND HEALTH REQUIREMENTS OPTIONS: PAGE

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5.12 Architectural Considerations 1
5.13 Mechanical Considerations 3

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5.23 Automatic Fire Alarm 4
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LIST OF ILLUSTRATIONS USED IN THIS SECTION:

Figure 5.1 I.S.O. Building Volumes
Figure 5.2 Corridor as Wet Spine
Figure 5.3 Plumbing Man Chase

SECTION 5.0 BUILDING SAFETY AND HEALTH REQUIREMENTS OPTIONS

INTRODUCTION:

Economical operation of a school facility requires careful consideration of effects from public usage, local environmental hazards, and fire safety. Attention must be given to minimizing potential damage due to vandalism, fire, and freeze-up.

5.1 VANDAL PROTECTION: The design of school facilities must include careful analysis of potential damage by vandalism. District maintenance personnel are a good source for identifying problem areas. Attention to this area throughout the design process, from facility masterplanning (is the school isolated from village making supervision difficult?) to the selection of materials, can save unneeded expense and hardship during the life of the school. Life cycle cost analysis of more durable materials and products may indicate savings over cheaper first-cost materials when vandalism is recognized as a problem. It must be understood, because of the remote location of facilities within this report, that the higher cost of a more durable item is insignificant when compared to installation and operating costs. Design, shipping, installation, and supervision costs are often the same for a cheaper, less desirable product, as they are for a more durable one.

5.11 Civil Considerations: Where applicable, the underbuilding area should be enclosed to reduce vandal damage to utility connections, piling fin-tube units, and the underfloor skin. Heavy gauge wire-link fencing can secure the area, and yet provide air circulation beneath the building where applicable. It should be noted that many times adequate enclosing over a long period of time becomes a maintenance chore due to the action of the soil. Movement of the soil's active layer can open gaps at the bottom of the enclosure or can pull the enclosure away from the structure, thus yielding access to the underbuilding area. Fencing around fuel tanks can inhibit vandalism.

Playing fields should be located so that they are easily visible and supervised from an occupied indoor area (teacher's work room would be good) and possibly from a teacher's or custodian's residence.

When selecting a site, consider that sites remote from the village historically experience more vandalism due to a lack of continuous observation.

5.12 Architectural Considerations:

5.121 Windows: Window placement may discourage abuse to external equipment and materials if vandals feel their actions may be observed from inside. Glazing (as noted in Section 8.5) should include a pane of Lexan or plexiglass to provide some protection in case of accidental or intentional breakage.

Operable windows should have operators that can be deactivated at the option of local school personnel. Depending on the school district's policy, window frames may be designed to be boarded-up with plywood for off-season security.

5.122 **Outside Lighting**: Outside lighting should be provided at all school entries, walks, and decks. Utility buildings should also have exterior illumination. Lighting fixtures should have unbreakable lenses, preferably out of reach.

5.123 **Doors and Locks**: See discussion in Section 8.62. Hardware should be selected that is not susceptible to tampering, such as large deadbolts, etc., and resistant to freeze-up and marine air corrosion where applicable. All access doors or panels inside or outside of school building utilidors and utility buildings should be securable via key lock to prevent unauthorized entry which could expose equipment or pipes to freezing or tampering. Masterkeying should be coordinated with the school district. For new school additions to existing facilities, the new hardware and keying may be matched to existing.

A building security plan should be developed for each school complex. The building security plan must address a hierarchy of spaces to be protected. The desirable hierarchy for spaces is, beginning with the most secure; service areas, office areas, classrooms, and circulation (exterior entry).

Special custom doors should be avoided; "off-the-shelf" stock doors offer easier and cheaper repair and replacement.

5.124 **Building Controls**: Controls for various building systems such as water, heat, and ventilation should be located where they cannot be tampered with by persons unfamiliar with the building's equipment. A good location is a locked mechanical room, janitor's closet, or school administrator's office, depending on school size, staffing, and sophistication of systems. Controls for lighting, fire alarms, etc., should be located in easily supervised locations.

5.125 **Insulation and Vapor Barriers**: Insulation and vapor barriers should never be left exposed or inadequately protected from accidental or intentional damage by people or animals. Particularly vulnerable are the underfloor areas where damage to insulation can be a problem to mechanical systems. Also, exposed weatherstripping and caulking, particularly at doors and around play areas, can become the subject of interest.

5.126 Finishes: Interior and exterior building finishes should be easy to maintain and repair without exposed fasteners or seams that may easily be tampered with. Hallways and bathrooms can easily be subject to heavy wear and abuse. Wainscoting of wood or plastic laminates has proven very durable. Vinyl wall coverings should be used with care because seams can easily be picked at and peeled back.

Floor finishes in any space where water is supplied should be non-absorbent, with floor drains and waterproof coving whenever possible. Self-coving sheet vinyl floors can be easily punctured by equipment or people if not reinforced at bends.

5.127 Building Furnishings: Lockers and partition systems can be subject to much abuse. They should be of suitable school quality. Lockers and showers have provisions for padlocks (built-in locks should not be used without owner's approval). Lockers with exposed tops should have a sloping top to discourage stacking material or sitting on them.

5.128 Partitions: Folding, accordian, or demountable partitions should be finished in durable materials with sturdy operating hardware. Attention should be given to the quality of the manufacturer's supplied miscellaneous trim materials. Observations at several new rural schools have shown that trim materials often seem to be a maintenance problem.

5.13 Mechanical Considerations: The selection of equipment exposed to students must receive serious consideration to reduce vandalism that occurs in schools. The mere use of "vandalproof" equipment is not effective; it is suitable for commercial use, but not for school use. This problem is not restricted to rural areas.

5.131 Plumbing Fixtures: Plumbing fixtures should be heavy gauge metal and secured from the back (service) side with all required available services from the back side, and not accessible by any means from the front (public) side. The back side of fixtures should be accessible through a chase, storage room, or some other area that is secured by a locked door. Special heavy-duty detailing is needed for wall and floor construction that supports all plumbing fixtures so the fixture does not come off the wall (water closets, sinks, and drinking fountains are especially susceptible to students standing or sitting on them).

5.132 Piping: When piping is run exposed in corridors, it shall be durable and well fastened to withstand public exposure and such abuse as children swinging on it.

5.133 Terminal Heating and Ventilating Equipment: All grilles and registers should be of heavy-duty construction and installed to withstand severe abuse. Hot water baseboard, if used, should be of minimum 16 gauge steel; 14 gauge steel is preferred.

5.134 Access Doors: Access to mechanical equipment locations should be secured by heavy-duty steel doors with suitable hinges and locking hardware.

5.135 Fuel Storage: The diked fuel storage area may be enclosed by fencing to prevent tampering with controls, piping, and equipment.

5.2 FIRE PROTECTION:

5.21 Life Safety Code NFPA 101:

5.211 A rural school must have a manually operated fire alarm system; there must be at least eight fire exit drills per year.

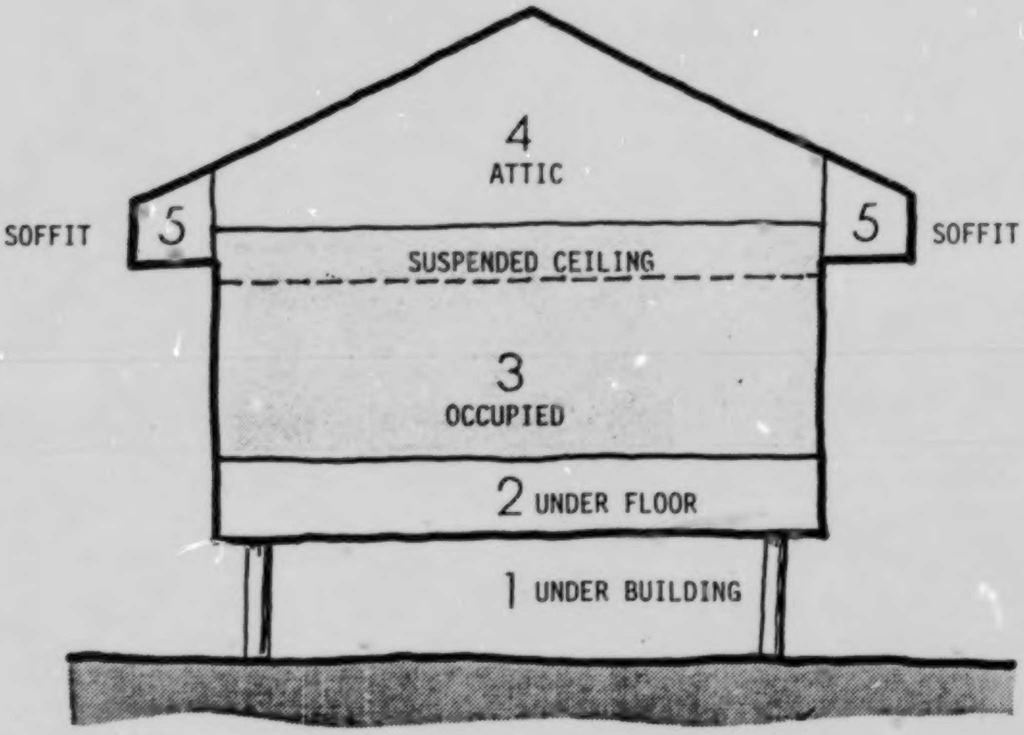
5.212 Any open-plan. or flexible plan school building with travel distance to exits exceeding 150 feet shall have a complete, approved automatic sprinkler system.

5.213 Operable windows for rescue and ventilation are required in school rooms per Section 9-2.12. Windows must provide a net clear opening of 22" x 24" in height, with the sill not more than 44 inches above the floor.

5.22 Manual Fire Alarm: This is a minimum requirement described in NFPA 101.

5.23 Automatic Fire Alarm: Reduced insurance rates and initial building trade-offs are possible with "rate of rise" temperature detectors and/or smoke detector systems. The decision for an automatic fire alarm system must be made by the owner with concurrence by the State Fire Marshal, the building architect, and his consulting engineer.

5.24 "Life Safety" Sprinkler System: This system is primarily used to protect occupants and not the structure. The benefits of a "life safety" sprinkler system should be given consideration by the architect, and the owner, to determine the most practical solution to providing fire protection. This type of sprinkler system has proven to be much less expensive than an "ISO approved sprinkler system", while providing a high degree of fire protection. A "life safety" sprinkler system does not always reduce insurance rates.


4
ATTIC
SOFFIT
5
5
SOFFIT
SUSPENDED CEILING
3
OCCUPIED
2 UNDER FLOOR
1 UNDER BUILDING

SECTION
I S O BUILDING VOLUMES

FIGURE 5.1

5.25 "ISO Building Sprinkler System: "ISO" stands for Insurance Services Office. This organization is a private rating bureau formed by insurance companies to establish building insurance rates for member insurance companies. Because ISO is a private body, it is often difficult for the public (designers and owners) to obtain specific information. ISO generally follows the guidelines set forth in NFPA Pamphlet No. 13. Basic guidelines are published; however, the final acceptance and insurance rate is unknown until the building and sprinkler system is tested by ISO. This automatic sprinkler system is then rated using a 100 point base and, depending on the quality of the system, an insurance rate is established. So, in essence, your approval is in degrees; not approved or disapproved but "scored".

Additionally, certain design options can be achieved, according to public building code, when installing an ISO system that qualifies as a code-approved automatic sprinkler system. The cost benefits of an ISO approved sprinkler installation should be reviewed if a One-hour Fire-resistive Construction reduction can be obtained on the building. If a code requirement necessitates a sprinkler system, then a One-hour Fire-resistive Construction reduction cannot be obtained. The specific options and economies for this must be carefully weighed before proceeding. Generally speaking, these design options may provide for more latitude within the code for fire restrictive construction.

5.251 Building Envelope Considerations: ISO has established ratings for various volumes within the building envelope. We will only address major items of the ISO rating system in this report. 1/ Figure 5.1 shows major volumes that contribute toward rating the building envelope for calculation of insurance rates. Considerations are as follows:

1. Code Requirements: For installation of sprinkler systems, NFPA 13; centrifugal pumps, NFPA 20. Code requirements for maintenance of sprinkler systems, NFPA 13A.
2. Two Basic Risk Categories: Fully sprinklered, and non-sprinklered.
3. Building Area Sprinklered: Fire insurance credit is given if 25% of the total building area, or one entire story, is sprinklered (exact credit varies).
4. Water Source: Amount of water based upon NFPA No. 13. Quality of source based upon NFPA No. 20. Generally, public water systems, swimming pools of adequate capacity, and/or an approved storage tank with required capacity will be acceptable.

1/ ISO information taken from Minutes of Meeting with ISO representative on 4/7/78 and 7/25/78. All information contained herein is to be used as a guide only; subject to reinterpretation by ISO.

5. Pumps (All U.L. Rated): A single diesel or electric pump is considered minimum protection in connection with the above water systems. An electric primary with electric standby is ideal for a private water supply. Further, an auxiliary generator with an independent circuit will improve either of the above two installations.

6. Building Construction: The greater the fire resistivity of the structure, the greater the fire insurance savings. For example, a wood frame building with the highest quality sprinkler system will have higher rates than a noncombustible building of the same system.

   Any combustible attic, underfloor or truss space, underbuilding, or soffit space (over 30" projection) should be noncombustible construction and/or sprinklered to obtain the best insurance rates. In most cases, noncompliance will not eliminate the building from being rated as a sprinklered building.

   The term "noncombustible material" relates to fire retardant treated wood with a flame spread rating of less than 25 (metal, masonry, etc.).

7. Other Buildings:

   a. Exposure to an unsprinklered building: Rate varies by proximity, type of construction, and occupancy.

   b. Exposure sprinklers protecting the wall of the risk exposed will decrease the insurance rate.

8. Dry Pipe Systems with Approved Exhauster or Accelerator:

   a. Advantages: No water in pipe to freeze and damage system.

   b. Disadvantages: More expensive than wet pipe; very difficult (takes trained person) to reset after activated; system is charged with water when a head goes off, and therefore is susceptible to freezing; pipes must be sloped to drain. Avoid in bush construction because of maintenance needed.

9. Wet Pipe Systems:

   a. Advantages: No delay to reacting to fire; more economical installation and maintenance than dry pipe system.

   b. Disadvantages: Must be in warm part of building.

10. Extinguishers and Hose Cabinets: Additional credit given for extinguishers and hose cabinets. No additional credit given for hose cabinets if the building is sprinklered.

5.26 Fire Hose Cabinet: The fire hose cabinet can be located near an exit for fire suppression outside of the structure. A backup pump for the fire hose supply is recommended in the event primary power is out when the fire hose is needed. Upon approval from the State Fire Marshal, a fire hose cabinet requirement may be deleted in lieu of portable fire extinguishers when deemed appropriate.

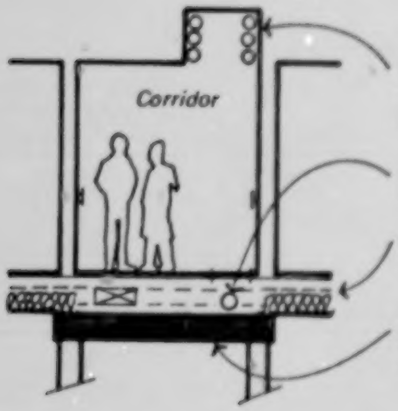
5.27 Fire Extinguishers: Portable fire extinguishers are imperative due to the constant threat of a lack of water. Generous distribution of these throughout the facility, especially in high hazard areas, i.e., shop, kitchen, lab, home science, generator and mechanical rooms, is minimum insurance for building life safety. The designer is referred to NFPA 13 for the type, size, number, and location of fire extinguishers.

5.3 FREEZE-UP PROTECTION:

5.31 Building Design: Initial identification of all potential water use areas for planning simple, accessible wet systems is a major deterrent to freeze-up damage. A good concept is to locate all wet areas on a plumbing man-chase for complete accessibility in case of freeze-up. This can either be a separate chase or be part of the mechanical room. (See Figures 5.2, and 5.3). The exposed plumbing in this space can be easily heated by a portable heater during a heating system failure to prevent damage. All plumbing can be located above the floor in this concept, with waste flowing to a localized sump and being pumped overhead. (See Figure 5.3). Sometimes buildings can be planned to take advantage of topographical elevation changes and have the sewage flow by gravity and still be above-floor for accessibility.

At the completion of the design process, the design firm should submit a freeze-protection plan outlining the steps required to allow the building to go below freezing without damage upon the occurrence of a major fuel failure, electrical power failure, or any failure making the heating system inoperative. The outline should also include a start-up procedure to restore the building back to a normal, usable temperature under severe outside weather conditions. This plan should be integrated into the school maintenance and operation manual.

In general, the above requirement applies only to protecting the building plumbing systems. This requirement will prompt the system designer to insure that the plumbing lines can be drained and that drain valves are accessible because, at some point in the life of the building, failures will occur mandating a plan for this occurrence.



Mechanical piping (water) should be run overhead to reduce potential for freeze-up and be accessible for maintenance.

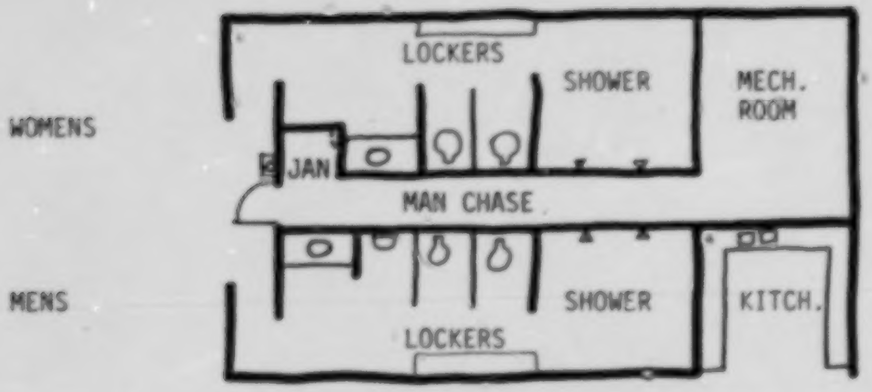
Waste pipes may be run below floor in heated spaces but must also be accessible.

Air supply and return ducts may be run below floor to help maintain a warm floor.

Recommend use of rigid insulation below piping runs to reduce potential water damage.

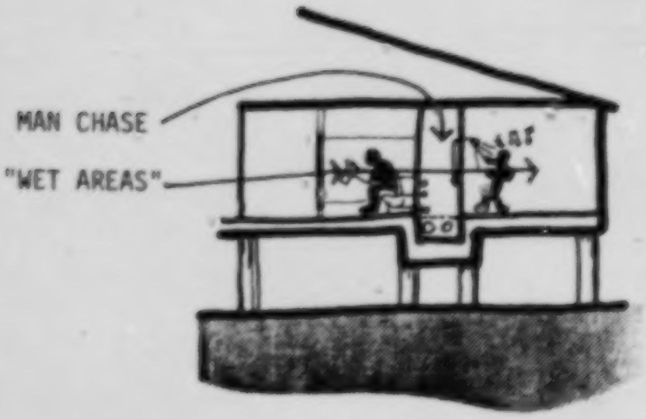
CORRIDOR AS WET SPINE

FIGURE 5.2


WOMENS
LOCKERS
SHOWER
MECH. ROOM
JAN
MAN CHASE
MENS
SHOWER
KITCH.
LOCKERS

TYPICAL PLAN

ORGANIZING "WET AREAS" AND BACKING ALL PLUMBING FIXTURES AGAINST A MAN CHASE


MAN CHASE
"WET AREAS"

SECTION

PLUMBING MAN CHASE

FIGURE 5.3

5.32 Building Operation: During severe weather conditions, a fuel interruption, an electrical outage, or any failure making the heating system inoperative allows a time span of two to four hours before action is required to prepare the building for freeze-up protection. Consideration should be given to a self-contained alarm device at a critical location in the plumbing system to indicate a temperature of approximately 40 degrees F., signalling the preparation for manually draining the system, and charging all traps with antifreeze or blowing all traps clear of water. The use of automatic drainage of the plumbing system is not recommended. The sophistication of controls, sensors, and alarms would be too overwhelming for consideration.

As a preventive measure to avoid the need of extensive preparation of the building for freezing temperatures, other cost-effective methods for providing minimum emergency heating must be considered; for example, a small gasoline generator can keep the heating system functioning. The use of gravity flow or minimum-lift fuel oil supply to individual oil burners simplifies freeze preparation.

5.4 CODE IMPACT: There are various aspects of the currently enforced Uniform Building Code, Uniform Mechanical Code, and National Fire Protection Association Pamplets which affect building utility systems adversely. A standard policy must be implemented and published by various regulatory agencies in the review of plans and specifications to accept variances or unified interpretation. The State DOT/PF must give serious consideration to obtaining uniform interpretations and systems' approvals from public regulatory agencies. A program of careful analysis and research for proposed solutions should be prepared and submitted to testing and/or national regulatory organizations as a basis for local approval.

5.41 UBC Occupancy Loads: Table No. 33A defines the building square footage per occupant for a specified use. Therefore, the number of occupants for life safety is determined on the floor area for a specified area being considered. The number of occupants then determines the width of corridors, width and number of exits, and requirements for ventilation. While this is necessary for emergency exiting, it would be more reasonable to base ventilation requirements and the number of plumbing fixtures on an assumed community load. For instance, a gymnasium may have a floor area that would indicate a number of occupants in that gymnasium far exceeding the number of occupants in the entire community; therefore, the ventilation required by code would far exceed a more realistic quantity of air based upon community population. The requirements for determining the number of users and plumbing fixtures vary between the UBC and the UPC; a published list of which code governs is needed.

5.42 UBC Requirements for Group "E" Occupancies: The State Fire Marshal has interpreted UBC, Section 802(d), Special Hazards, with regard to One-hour Fire-resistive Occupancy Separation requirements between rooms using flammable liquids, combustible ducts, etc., and the other portions of the building. 2/ Examples of the importance of such an interpretation can be illustrated when considering the lab, science, and vocational education areas. The lab and science area must be separated from the rest of the academic area in a small "open-plan" school (illustrated by sample schematic floor plans for an enrollment group of 10 or fewer students in Section 4.0). This sample solution is based on One-hour Fire-resistive Construction throughout, and considers other course offerings being taught in the science area. (The reader must be cautioned to seek individual interpretations and approvals). The Fire Marshal currently interprets lab science and voc. ed. as similar use areas, and both are subject to the One-hour Fire-resistive Occupancy Separation as per UBC, Section 802(d). Current interpretation is that each activity in the voc. ed. area addresses a separate hazard per UBC, Section 802(d), and has to be separated from each other.

A One-hour Fire-resistive Occupancy Separation is needed between wood shop, welding, automotive repair, and finishing (painting). Both of these examples have strong effects upon economic space utilization within the school. It has been suggested that the problems associated with the second example (wood shop, welding, paint, auto) might be alleviated by developing a certified use permit mechanism wherein the school district superintendent would certify that only one hazardous activity at a time would be offered during designated periods of the school year. The reader is reminded to contact the State Fire Marshal's office with regard to any future use permit program.

5.43 Storage and Janitor Closets: Storage and janitor closets shall be separated from other parts of the building by One-hour Fire-resistive Construction per UBC, Section 802(c).

5.44 Automatic Door Closers: The State Fire Marshal suggests (not requires) that whenever a door closer is needed by code, a magnetic door holder be incorporated. 2/ A battery operated system would make this independent of primary power outages. The reasoning behind this is that users prop the doors open mechanically, which negates the function of the closer. The reader should weigh the trade-offs between additional safety and additional first cost, and also consider another sophisticated system that may fail and not be readily repaired.

2/ Taken from Minutes of Meetings on 6/12/78 and 7/25/78 with State Fire Marshal. Subject to reinterpretation by State Fire Marshal's Office; reader to confirm details.

5.45 Two-story Building: Currently, the State Fire Marshal is interpreting attic storage space as potentially occupied space, and conversely this requires One-hour Fire-resistive Construction throughout the building. 3/ This affects building construction, design, and cost. The reason behind this interpretation is that, historically, any room not totally occupied by fixed equipment will be occupied by the user as a classroom space.

5.46 UBC Requirements for Fuel-fired Equipment Room Exiting: In Section 3320(s) and Table 33-A, the code addresses the need for two means of egress or two exits under certain given conditions. The code is not explicit when a fuel-fired equipment room has characteristics that allow only one exit (as to the specific requirements for that one exit). The State Fire Marshal's interpretation is that when only one exit is required, it must be an approved exit and not just a means of egress. This has serious effects upon locating a fuel-fired equipment room, i.e., if the fuel-fired equipment room is located in the attic of a structure, it must then have an approved exit (fixed stairway). 2/

5.47 Uniform Mechanical Code Combustion Air Requirements: This is a continuing source of problems in building plan review and building operation. Table No. 6-A of the 1976 UMC should not be used for sizing of combustion air requirements. All combustion air in Alaska should be designed under Section 607-A-F, but in particular, under Subparagraphs E. and F. The State Fire Marshal has approved the use of a two-position motor-operated damper in the combustion air intake when it is interlocked with burner controls so that burner controls will not operate unless the combustion air damper is open. The trade-off for any benefits of this approval should be weighed against the additional sophistication of such a system. The State Fire Marshal interprets UBC, Section 3320, as requiring a six inch noncombustible sill (dike) to be provided around the floor combustion air duct so oil spilled in the building does not immediately flow outside and under the building. 2/

5.48 Fire Damper Requirements: The Uniform Building Code requires fire dampers in One-hour Fire-resistive Construction, whereas the NFPA does not require a fire damper in less than Two-hour Fire-resistive Construction as related to walls and partitions. The 14th Edition of the NFPA Fire Protection Handbook allows that standard galvanized steel ductwork in the sizes required for the air systems provides one-hour protection. At the present time, no UL fire damper is manufactured that carries a 3/4- or one-hour rating. The least rating that can be attained is a 1-1/2-hour rating for a two-hour wall. This is a needless and unnecessary expense and an operational problem imposed by the Uniform Building Code.

2/ Ibid.

3/ Taken from Minutes of Meeting on 6/30/78 with State Fire Marshal. Subject to reinterpretation by State Fire Marshal's office; reader to confirm details for specific designs.

5.49 Plenums: The use of corridors and ceiling spaces as supply or return air plenums (UMC, Section 1008) requires clear code interpretation for both combustible and noncombustible construction. A definition of limited combustible material must be considered.

It should be noted that the State Fire Marshal's office cautions that fire-retardant treated wood will become very dry and its fire-retardant potential is reduced when used as an air plenum or duct. Therefore, this material is not approved for use as a duct per UMC, Section 1002. 3/ The designer should be cautioned that the chemicals used in treating fire-retardant treated wood may require special selection and application of finishes and can affect the performance of a finish differently than on untreated wood.

5.50 Fire Codes Enforcement: The State Fire Marshal's office will adopt the ICBO codes (UBC, UFC, UMC, etc.) as primary enforcement and the NFPA as secondary enforcement. This means that for any conflicts between ICBO and NFPA, ICBO will govern. NFPA provisions will only be enforced when an item is not addressed as a requirement of ICBO. 4/

5.51 UBC Fire Resistive Construction Requirements: A discussion of some basic differences between requirements for One-hour Fire-resistive Construction and One-hour Fire-resistive Occupancy Separation follows: protection for openings are a basic difference between these two requirements. One-hour Fire-resistive Occupancy Separation openings are protected by a fire assembly having a one-hour fire-protection rating (UBC, Section 503(c); whereas openings within one-hour fire-resistive construction need not be protected by a rated-fire assembly. When one-hour fire-resistive construction is required for a corridor (UBC, Section 3304(g)), every door opening shall be protected by a tight-fitting smoke and draft control assembly having a fire protection rating of not less than 20 minutes (UBC, Section 3304(b)).

5.52 UBC Flame Spread Classification: Often, requirements for a flame-spread rating are confused with fire-resistive or noncombustible construction requirements. Flame-spread is a rating given to the surface boring characteristics of a material. Flame spread rated materials may constitute the finish of a fire-resistive or noncombustible assembly, but may not be fire-resistive or noncombustible in themselves.

End of Section

3/ Ibid.

4/ Taken from Minutes of Meeting on 7/18/78 with State Fire Marshal. Subject to reinterpretation by State Fire Marshal's Office; reader to confirm details for specific designs.

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SECTION 6.0 SITE UTILITIES

INTRODUCTION:

Site utilities include water supply, waste water disposal, solid waste disposal, electrical power, and fuel supply. There are a multitude of diverse systems that fall in the category of utilities. These systems can be simple or complex in function and design; the degree of complexity of the systems is based on the environmental constraints and the technological ability of the operator.

The owner of the system wants it to be functional, yet simple to operate; he also wants the quality to be good while keeping the price to a minimum. The designer is faced with difficult conditions, but is asked to meet rather rigid requirements. New solutions are frequently needed, but the harsh climate of Alaska is cruel to most innovations.

Water utility is concerned with supplying and delivering sufficient water for internal and external use by people. The quality of water is limited to nontoxic conditions when supplied as potable water. Additional treatment of water is a sociological decision and usually relates to the degrees of color, turbidity, hardness, and taste. Additional treatment may be required for waters used in mechanical systems that are sensitive to scaling or corrosion.

Each water source is unique and requires comprehensive chemical and biological analysis during each of the seasonal variations. A stream or river source will show different qualitative characteristics during spring break-up. Wells may also vary in chemical quality with the change of seasons and the height of the groundwater table. A system that gathers precipitation into a storage tank produces high quality water, but the chances for contamination are great and the supply depends on the whims of the weather.

Waste water disposal involves all systems that gather, treat and dispose of water-borne waste from those using the school facilities. The systems that have been developed to accomplish the disposal task are many and varied and have succeeded or failed for myriad reasons.

The greatest need in waste water systems is to design the most workable solution that will operate in a harsh environment at a reasonable cost. The design options outlined below are given as a guide to one who must cope with the difficulties of a remote location and a low level of availability of technical resources.

Solid waste disposal for village schools can usually be taken care of by a good program of collecting refuse and transporting it to a suitable disposal site. The problem of transportation, wind scattering, and ultimate disposal are discussed herein.

Without exception, electrical power is needed for the operation of a school facility. Lighting, heating and ventilating, together with utility delivery, require reliable electrical power during the whole year. This section discusses the aspects of power supplied by existing systems and the requirements of school-supplied power on a regular or emergency basis.

Fuel storage is discussed with emphasis on required capacity and workable system options.

6.1 WATER:

6.11 Existing Piped System: An existing piped system is usually an underground insulated pipe, a pipe in an insulated utilidor, or an aboveground insulated pipe or utiliduct. This type of system has normally been installed by the U.S. Public Health Service (PHS) and is owned and operated by the village. (See Figure 6.1).

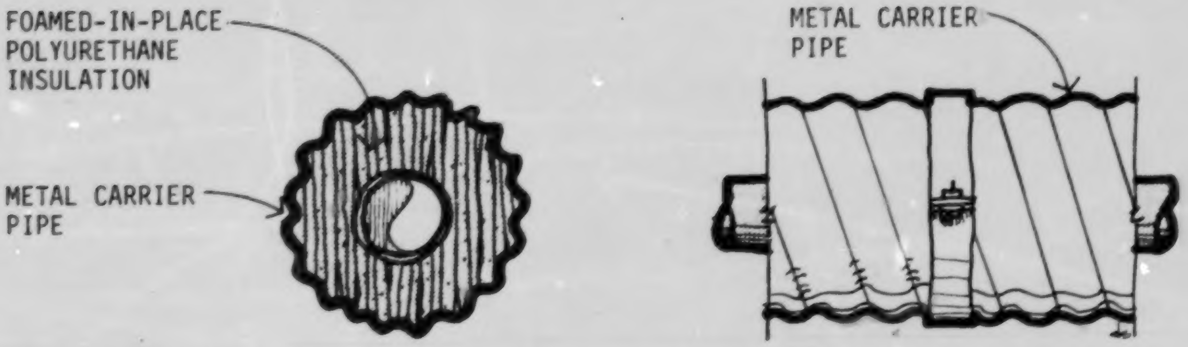
The major advantage in connection to a piped system is the reduction in both initial and operating costs. A flat fee user charge is normally paid directly to the village on a projected year-round demand. The only requirement placed on the school is construction of a service connection.

The disadvantage of existing systems lies in the fact that no control over the maintenance and operation of the system is held by the school district. Since a central system is much larger than an individual supply, the potential for failure at any one of many points is greater.

6.111 Minimum Requirements: Determine existing gallon per capita per day load on system. Determine pressure drop generated by school demand and ascertain any need for additional pressurization. Determine need for added storage capacity.

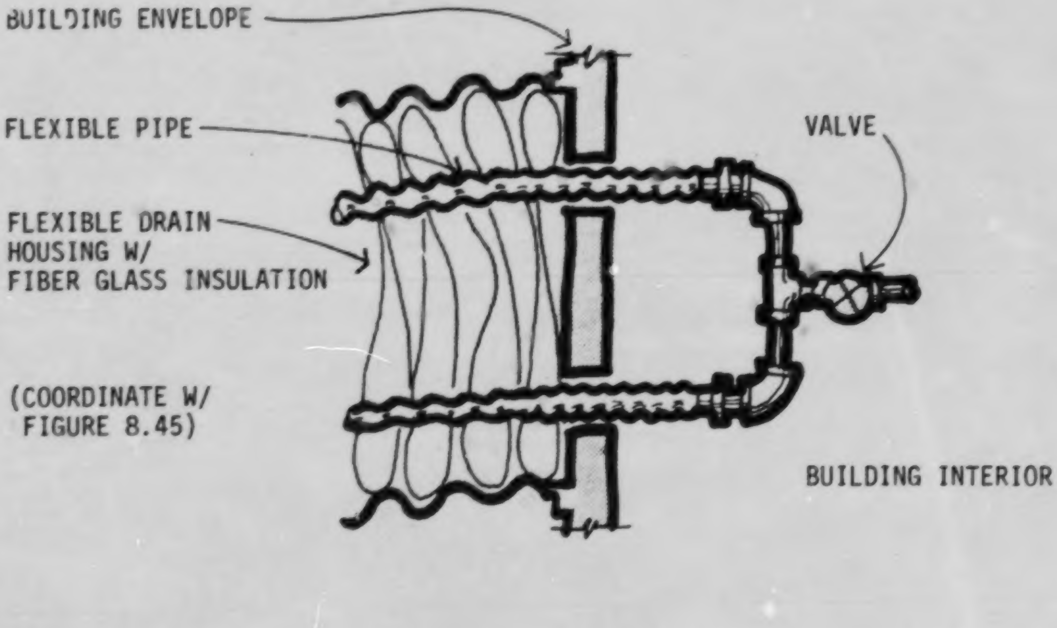
Establish agreement with utility owner (usually village) and school district.

6.112 Method of Interconnect: Determine if the system is aboveground or a buried insulated transport system. Service connections should utilize a pitorifice type of connection, or other type, with supply and return lines to minimize freezing of the line. Length of the service line should not exceed 50 lineal feet, if possible. High friction losses will require additional pressurization if small diameter piping and long runs are used, while low velocity and increased susceptibility to freezing occur in large diameter service lines. (See Figure 6.2).


FOAMED-IN-PLACE POLYURETHANE INSULATION
METAL CARRIER PIPE
METAL CARRIER PIPE

TYPICAL ARCTIC PIPE

FIGURE 6.1


BUILDING ENVELOPE
FLEXIBLE PIPE
FLEXIBLE DRAIN HOUSING W/ FIBER GLASS INSULATION
(COORDINATE W/ FIGURE 8.45)
VALVE
BUILDING INTERIOR

TYPICAL RECIRCULATING WATER CONNECTION AT BUILDING

FIGURE 6.2

6.113 Method of Freeze Protection: Most existing piped distribution systems rely upon a combination of recirculation and the addition of heat. Service connections to these systems should provide additional pumps if the service connections are excessive in length. In areas where the duration of below-zero temperatures is long, the addition of heat tapes is recommended.

These heat tapes should be connected to probes that automatically activate the tape when the water temperature drops below the predetermined minimum return water temperature at the originating pumphouse. Additional protection in the form of thaw wires that can be attached to a portable generator should be provided at points where the service connection meets the existing line, and at the building line. Service connections should be encased in preinsulated utiliduct. (See Figure 6.2).

6.12 Existing Watering Point: This type of facility can range from a large storage tank with a limiting valve connection for public use to a shower/laundry/treatment plant facility with a storage tank. The former is normally located in those areas where a limited seasonal water source is available. The latter is located in areas where a constant year-round supply of water is present, but where other conditions make use of a piped system unfeasible. Some of these conditions might include permafrost or a high water table, making pipe laying difficult, or a lack of full-time experienced operators for a distribution system. Many of the new facilities under construction by PHS are sized to support a village at an average daily usage of 25 gallons per person. The older seasonal storage systems are based on an average daily usage rate of five gallons per person.

Use of this system for a secondary school relieves the need to develop a water source and storage system. Countered against this is the requirement to provide an interconnect for the school, either through a piped system or a truck haul system. Metering devices must be installed if a piped interconnect is used because most water supplies from storage tanks are sold on a per gallon basis. The difficulties with truck haul are obvious in that transportation is not always reliable; water can be contaminated through exposure during handling; and there is always inadvertent wastage.

6.121 Minimum Requirements: Determine annual usage required by the school. Verify that existing storage is adequate; often, existing tanks are sized for winter supply of villages based on 5 gpcd. Establish an agreement with the owner for annual usage costs.

6.122 Method of Delivery. When the new school location is close to an existing water storage tank, establish a direct piped system with meter and/or limiting valve. If a piped system is unfeasible, evaluate whether truck haul to the holding tank at the school is more cost effective than installation of a new separate water storage tank at the watering point.

6.13 Provide New Well: Where a well is indicated as being a viable source of water, this becomes the most preferred system. Usually wells are located immediately adjacent to the structure being served. This minimizes the danger of freezing of the supply line.

The main disadvantages in a well system are:

1. The aquifier that supplies the well is inadequate and dries up.
2. The aquifier becomes contaminated by saline water and is unusable.
3. The well may have to penetrate a permafrost layer that creates freezing problems in the well.

6.131 Minimum Requirements: Establish existence of aquifer by examination of BIA, PHS, USGS, or ADNR well logs, if possible. Determine minimum gpm requirements for school usage. This may be difficult without a good knowledge of the projected use of the school for community functions; school district policy on the use of a school water source for the community should be clearly known before a well is designed.

6.132 Method of Delivery: Use submersible pumps whenever feasible. Locate as close to building as possible to minimize potential of damage to supply line. Bury the supply line below the active frost layer. If line is laid in high water table, provide corrosion resistant materials as protection. This may be copper or steel pipe laid in PVC casing.

6.133 Method of Freeze Protection: Use of insulated casing is recommended when wells penetrate permafrost zones. Wrapping of the exterior skin with plastic film, at the active layer only, reduces or eliminates frostjacking of the casing. Thaw wires connected to the piping can be used if the exterior casing will not burn or melt.

6.134 Method of Treatment: Pressurization of the system is normally required when the water source is a well. Use of hydropneumatic tanks will satisfactorily supply required pressure for building distribution.

Water treatment can be varied from none at all, through biological treatment only, chemical treatment and filtration, to reverse osmosis for reducing salinity. Analysis of well water for contaminants is required. The type of treatment must be determined by the level of contamination and technological expertise of maintenance personnel available to operate a treatment plant.

6.135 Operation and Maintenance Requirements: Operation and maintenance of a well in itself requires little time or expertise. Control and operation of any water treatment associated with the well often requires daily monitoring.

6.14 New Surface Water Supply - Continuous: Surface water sources consist of rivers, lakes, and/or fresh water lagoons. Use of this type of source is indicated whenever a community system is not available or a well is unfeasible. (See Figure 6.3).

The major difficulties in surface water supplies are both environmental and technological. Freezing of sources and/or transmission lines present an annual hazard. The variation in water quality throughout the year provides technological difficulties in treatment techniques. The use of surface water is endangered by many forms of contamination. It is the Alaska Department of Environmental Conservation's policy that all surface waters must be filtered and chlorinated before use.

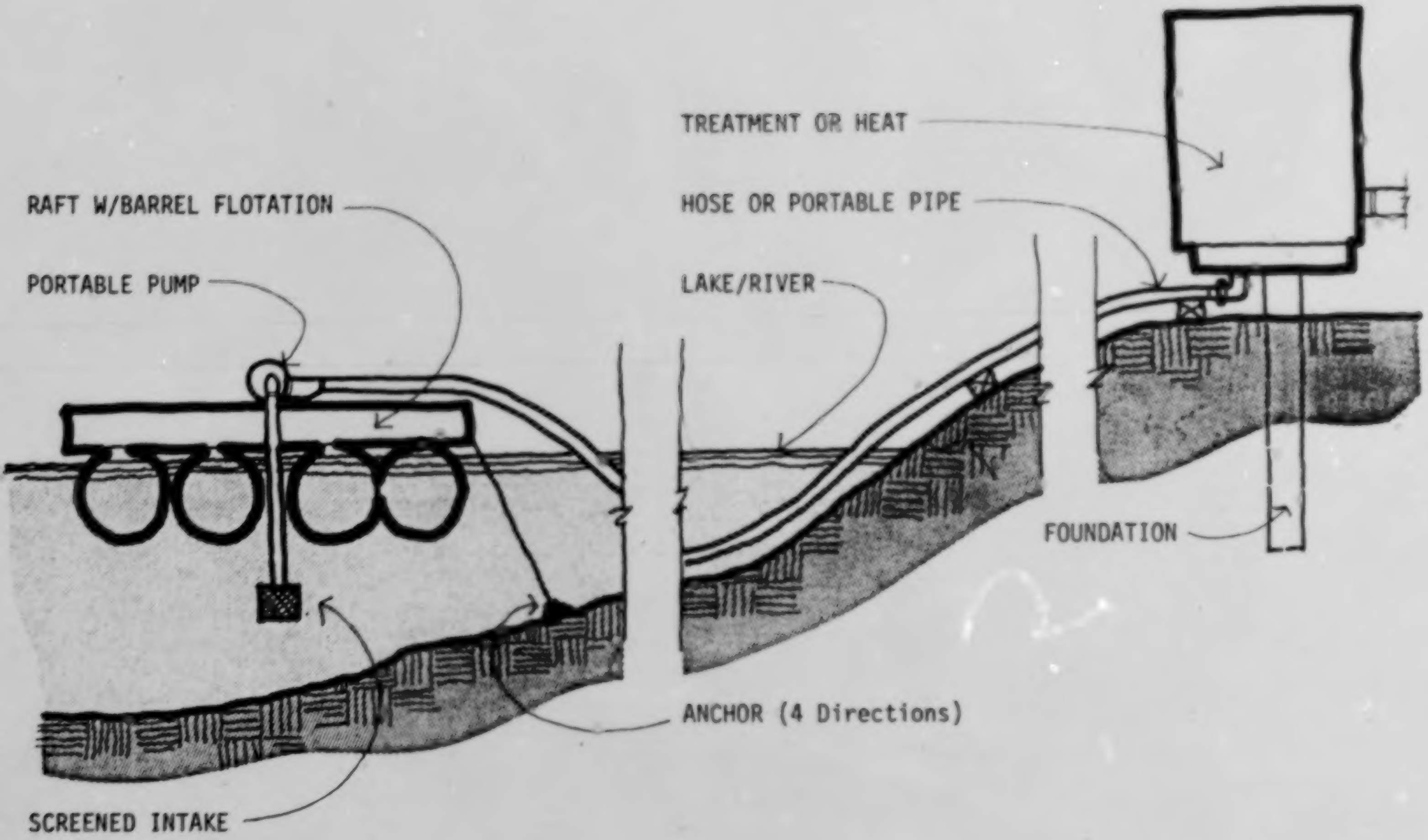
6.141 Minimum Requirements: Determine quantity and quality of water available. If the intake structure can be impeded by ice, use of an infiltration gallery beneath or adjacent to the source can offer protection.

6.142 Method of Delivery: Size piping to carry maximum gpm based on projected student enrollment and/or community use (if applicable).

6.143 Method of Freeze Protection: Buried insulated pipe is recommended to reduce heat transfer. In those areas where the active frost layer extends to the permafrost, addition of heat energy at the source is a requirement. In those cases where water flow may be static for an extensive period due to zero demand, the use of heating recirculation lines may help prevent freezing of the water piping.

6.144 Method of Treatment: State drinking water standards require a minimum of chlorination and cartridge filtration of all surface waters. Further treatment is dependent on chemical analysis. Level of treatment is dependent on technological level of maintenance personnel and contaminate the water.

Section 6.0/ Page 5 a.


TREATMENT OR HEAT
RAFT W/BARREL FLOTATION
HOSE OR PORTABLE PIPE
PORTABLE PUMP
LAKE/RIVER
FOUNDATION
ANCHOR (4 Directions)
SCREENED INTAKE

WATER SUPPLY - SURFACE

FIGURE 6.3

6.145 Operation and Maintenance Requirements: Operation of any treatment equipment requires daily monitoring by trained personnel. Processes may be automated if the water quality does not deviate from season to season; this is generally not the case in Western Alaska. Automated systems have a tendency to fail when weather conditions make access to the village an impossibility. Use of manual systems are more desirable. Clear instructions, both verbal and pictorial, should be displayed in areas where water treatment equipment is located.

Periodic maintenance of pumps and heat systems is necessary for trouble-free delivery of water. Redundancy of pumps and boilers is recommended based on a past history that shows a need for backups. Alarms that are activated by low flow or low temperature should be connected to the maintenance room. In those systems where "no flow" conditions are periodic, alarms that activate upon pump malfunction should be installed. All alarms should be battery operated in case of a prime power failure. Klaxons or similar devices that alert the entire village are desirable.

6.15 New Surface Water Supply - Intermittent Recovery: Many Western Alaskan villages have surface water sources that are usable only in the summer season. Either the quantity available is very limited, such as a lagoon, or the depth of freeze extends to the bottom of the source. Use of storage tanks sized to accommodate a full winter's supply is necessary. Filling the tanks during spring break-up and again during the rainy fall season will help those sources that are limited by size.

Operation and maintenance of the water transmission line can be optimized by use of flexible materials. The line can be laid on the ground surface and is easily accessible to inspection.

The major problem with a storage tank system lies in the control of the usage. Indiscriminate wasting of water will exhaust the storage capacity prior to spring break-up and availability of water. Use of low-flush toilets and/or limiting valves is necessary, along with an education program for the users. (See Section 9.32) As with other surface water sources, there is also the ever-present threat of contamination; all such water must be filtered and chlorinated as minimum treatment.

6.151 Minimum Requirements: Determine water use for enrollment group. Provide storage based on duration of freezing season. Because the time of spring break-up varies as much as a month over the year, allow for an additional two months' storage. This should provide enough supply to allow for the concentration of contaminants which forms at the bottom of the storage tank. This concentrated water should be drained and discarded prior to spring or summer refill.

6.152 Method of Delivery: For sources that are reasonably close to the storage tank, aboveground piping may be utilized. Use of high-polymer plastic pipe is recommended. This form of piping is elastic and highly resistant to damage from freezing, which can be critical if the piping is not thoroughly drained at the onset of freezing conditions. Use of aluminum irrigation pipe is an alternative, but has some inherent problems. Aluminum pipe should be taken up each fall to prevent damage from snowmachines, vandalism, etc. Those sources which are distant from storage may require a form of truck haul. Tanks should be located as close as possible to the building, with an insulated line directly to the point of delivery in the school.

6.153 Method of Freeze Protection: Insulation of the storage tank will reduce the requirements of supplementary heat introduced into the water supply. Circulated warm water may be required to keep water in usable liquid form. Where tanks have no insulation or heat added of any kind, i.e., when freezing occurs, the amount of usable water is reduced and the tank may be damaged structurally by ice build-up.

6.154 Method of Treatment: The Alaska Department of Environmental Conservations's policy requires both biological decontamination and cartridge filtration as a minimum requirement for use of any surface waters. Additional chemical treatment required is based on contaminant levels and technological expertise. Treatment can occur prior to storage if the tank is protected from contamination. If any form of contamination can occur in the tank, post-storage treatment of the water is recommended.

6.155 Operation and Maintenance Requirements: Drainage or disassembly and storage of the fill line to the storage tank prior to freeze-up should be accomplished to minimize damage from ice. Careful selection of a source and design of a portable intake structure to minimize collection of sands, silts, and parasitic organisms will aid in keeping maintenance efforts low. Low-temperature alarms with klaxons should be installed in all water storage systems. Maintenance of pumps and heating elements should be carried out on a periodic basis. Ongoing instruction for daily monitoring of water treatment, and visual maintenance aides posted in the treatment areas, are recommended.

6.16 Salt Water Source: Those villages with very limited sources of potable water often utilize salt water as a fluid medium for sanitation purposes. This is one type of system referred to as a "black water" system. It should be considered only as a last resort solution. Its use requires either a supplementary precipitation collection system or advanced physical-chemical processing for potable water.

When saline water is used for "black water" purposes, its effect on plumbing is considerable. The cost of plumbing maintenance should be weighed against the convenience of using such water for flushing.

6.161 Maximum Type of Usage: Brackish or saline water is usable in an untreated form only for "black water" systems. This requires two separate piping systems and should only be considered when no other alternative is available.

6.162 Method of Freeze Protection: If the salt water system is piped, insulated systems are required. Although salt water is less susceptible to freezing, given adequate time of exposure, it will freeze with the same consequences as a fresh water system.

6.163 Method of Treatment: If the salt water is to be used as a "black water" supply only, no treatment is required. If an attempt is made at converting brackish or saline water to potable water, either a steam distiller or a reverse osmosis unit is required. The first requires exorbitant amounts of heat and cooling to provide even limited amounts of potable water. The second process is reasonable only if restricted quantities are allowed.

6.164 Operation and Maintenance Requirements: All systems using salt water are subject to severe corrosion. Problems from corrosion can be reduced by use of marine fittings or inert materials such as PVC. Problems that are common in distillation or osmosis units require expert daily attention. Operational costs are sufficient to rule out this type of recovery except in the most severe cases.

6.17 Precipitation Supply: In areas where wells cannot produce satisfactory quality water, and no natural streams or lakes are available, the only feasible water source may be precipitation in the form of rain or snow collected on the ground or on roofs. In Western Alaska, the time for collecting from this source is limited to the period from spring break-up during May and June through September or October, depending on the whims of the weather.

The chemical quality of rain or snow water is suitable for all water uses, but the chance of biological contamination is great when water is collected from an open area.

6.171 Minimum Requirements: Attempts to utilize snow and rain precipitation require thorough analysis of climatic data. For those areas that are deficient in records, a minimum of a two-year pilot study period should be undertaken to determine possible quantities available.

Collection systems are subject to contamination from airborne or ground surface pollutants. Collectors should be constructed of nonpermeable materials. Rain water collected can be siphoned off, whereas snow requires artificial means of melting or a retention period until natural forms of melting are available. Determination of the minimum usage for the facility is necessary to size the collector. In addition, storage tanks must be sized to accommodate the need for water when precipitation is not available or freezing conditions exist.

6.172 Method of Treatment: As with surface water sources, filtration and biological decontamination are necessary with a natural collector system. Additional chemical treatment is usually not required.

6.173 Operation and Maintenance Requirements: Care must be taken to avoid penetration of the impermeable seal of a collector system. Operator attention to removal of sharp objects inadvertently placed in the collector can be a daily project. Any pumps or heating devices require periodic maintenance. Again, alarms that indicate malfunctions and visual aids describing the maintenance process are necessary, along with an ongoing training program.

6.18 Applicable Codes: Title 18 of the Alaska Administrative Code, Chapter 80, Drinking Water.

6.19 Relative Importance of Determinants: Figure 6.4 shows in tabular form the relative importance placed on various determinants as they affect the options available for water systems for rural schools.

FIGURE 6.4

0 = Unimportant
1 = Minor Importance
2 = Important
3 = Very Important

DETERMINANTS / OPTIONS	Size of Facility	Water Source Availability	Power Available	Flooding	Permafrost	Climate	Maintenance Requirements	Cost	Technological Level	Treatment Requirements	Storage Requirements	COMMENTS
EXISTING:												
1. Piped System	2	2	2	1	2	2	2	1	2	1	1	
2. Watering Point	2	2	1	1	1	1	1	1	1	1	2	
NEW-GROUND WATER:												
1. Well	2	3	3	2	3	2	2	2	2	2	2	
2. Infiltration Gallery	2	3	2	3	3	2	3	2	3	3	2	
NEW-SURFACE WATER:												
1. River	2	2	2	2	2	2	3	2	2	3	2	
2. Lake	2	2	2	2	2	2	3	2	2	2	2	
NEW-PRECIP./ICE:												
1. Collector System	2	3	2	1	1	3	3	2	3	[illegible]	3	
2. Melting System	2	3	3	1	1	3	2	3	2	3	3	

6.2 WASTE WATER: (See also Section 9.32).

6.21 Existing Piped System: As with water supply, an existing waste water system in any village is probably one built by PHS, now owned and operated by the village. In some cases, an existing system can be a school system operated by BIA or the school district. The cost advantage of being able to tie into an existing system is obvious. However, the designer should be aware that just because a piped system exists, it cannot be assumed that we can hook into it. Agreements will have to be made prior to such a hook-up. Agreements between the system operator and the school district should be based on usage of the system; existing flows and predicted new school flows can be used as a basis for the agreement.

The condition of an existing system should be determined before deciding to connect to it. Agreements for use of an existing system should clearly set out where each party's responsibility extends. Provision should be made by the school district to handle emergencies such as power outages, during which lift stations may not function, or heat tapes may become inoperative.

6.211 Capacity: The capacity of the existing piped system to carry the additional load from the facility should be evaluated. If the existing system connects to a sewage treatment plant, capacity of the plant to absorb the load should be verified.

6.212 Method of Connection: Most existing piped systems are gravity flow. Siting of the facility should take the local topography into consideration in order to maintain an adequate slope.

For those locations that physically impede a gravity flow connection to the main, use of pressure pumps from holding tanks are an alternative. Pumps that include a macerator in the design will permit the use of small diameter pipe. Clean-outs should be provided at every 50-foot interval for reaming of plugged pipes. All pressure lines should be self-draining when pumps are not in operation.

6.213 Method of Freeze Protection: The use of insulated utiliducts will reduce the potential of freezing, whether the waste piping is buried or aboveground. Use of materials that are compatible with thaw wires and/or heat tapes, in those areas subject to long intensive periods of below zero weather, will also reduce the damage that can occur with frozen pipes. An alternative solution would be a recirculating hot water heat trace line installed in a utiliduct carrying the sewer main. (See Figure 8.45).

6.214 Operation and Maintenance Requirements: Pure gravity flow will require only that maintenance required to remove foreign materials, e.g., rags, stones, and sticks, that may be flushed into the system. If a pressure system is used, then periodic maintenance and cleaning of pumps and sumps is required.

6.22 Existing Bunker with Truck Haul: In small remote villages where groundwater or permafrost conditions will not permit other forms of waste disposal near a school, the use of an existing haul and bunker (pit) may be the best solution available for waste disposal. Where water is also scarce, this system of disposal may be the most economical choice available.

This type of disposal system requires constant collection and hauling away of wastes. In addition, the chances of contamination and disease transmission are great, and much care must be taken to do a distasteful job in a sanitary way. Vehicle and road maintenance are also a part of the system if it is to function well.

6.221 Capacity: Use of bunkers presupposes that either a piped water system is not available, or the topography, ground water, and/or permafrost make a piped system unfeasible. Bunkers provide disposal sites for self-contained wastes from portable toilets. When such a "honey bucket" system is used, "gray water" must be disposed of by piping away to some suitable disposal area such as an absorption mound. Determination of the capacity for self-contained "black water" disposal units and establishment of regular collection methods is required.

Holding capacity should be considered for those areas that have difficulty with vehicular transport. The use of humus-type "black water" systems may be effective in areas where high water tables prevent normal disposal methods.

6.23 Provide New Septic Tank: Where there is no existing system, or an existing system is not adequate to handle new waste quantities and ground conditions permit soil absorption, a septic tank will provide the most cost-effective waste disposal system. Of course, a septic tank does not dispose of water, so an absorption system such as a drain field or leaching pits will be included in the system.

If septic tank systems are well constructed and properly maintained, they will give good service for many years. Adequate separation from wells or other water sources must be maintained according to Alaska Department of Environmental Conservation regulations.

6.231 Capacity: In those areas where soil and ground temperature conditions permit use of septic tanks with soil absorption systems, the initial installation should be sized to provide treatment for the maximum projected enrollment group. Periodic overloads on the system from full community use of the system need not be included in sizing if the overloads occur no more than once per week.

6.232 Discharge Requirements: Standards developed by PHS's Manual of Septic Tank Practice define minimum requirements for septic tank sizing and soil absorption trenches or seepage pit sizing. Percolation tests of soils indicate permeability of soils to water movement, and are required by the State Department of Environmental Conservation when soils analysis of the site indicates more than 30% of the soils pass a #200 sieve. In those areas where a high water table occurs, additional gravel must be brought to the site to provide an absorption area.

Use of inert materials in areas of periodic high water table level will reduce damage from corrosion. Use of insulated pipe to the septic tank is recommended to minimize freezing possibilities.

6.233 Operation and Maintenance Requirements: Minimal maintenance is required for septic tank operation. Removal of excess sludge should occur on at least an annual basis. Soils may become clogged and require recharge by the use of hydrogen peroxide distributed through the absorption trenches. Use of a dosing siphon (periodic dumping device) following the septic tank provides a more uniform application of liquid to the absorption field and diminishes the soil-clogging properties of the effluent.

6.24 Provide Sewage Lagoon: Where ground conditions prevent absorption of septic tank effluent, the disposal system may have to be located aboveground in a man-made lagoon or in a natural pond. No artificial aeration would be provided in this option. Natural decomposition of wastes would be utilized. In most cases, the lagoon can be sized to dispose of the water portion of the waste by evaporation, and no outlet is needed.

There is an advantage to this option in having a low initial cost, except where materials for the dike must be transported at high cost. Protection of the public from contamination and odor problems are disadvantages of this system. Piping and pumping to a lagoon or pond also provide maintenance problems.

6.241 Minimum Requirements: Determine maximum size required to provide both aerobic and anerobic decomposition of waste. Single-cell lagoons may be constructed (or developed) when loads are small. The lagoon should be constructed so that contamination of potable water supplies is prevented. Pit liners or other impermeable membranes should be installed. Protection from trespass by humans and animals should be provided in the form of fences.

6.242 Method of Delivery: Aboveground or buried insulated sewer lines to the lagoon may be provided. Consideration of topography, ground temperature, and/or groundwater levels will determine whether the system is gravity flow or pumped.

6.243 Operation and Maintenance Requirements: Minimal maintenance is required for the lagoon proper. Periodic removal of airborne debris to prevent damage to discharge structures is recommended. Systems which utilize pumps require regular periodic maintenance. Redundancy (backup) in pumps is recommended.

6.25 Sewage Treatment Plants: For schools with a student population ranging up to 46 persons, any type of sewage treatment plant will have to be of a minimum size of any standard commercial manufacture available. A "residential" type plant would handle the flows for the minimum sized (up to 10) school. Such plants usually consist of only mechanical aeration for treatment, and would require separate chlorination before discharge into receiving waters.

There are choices in package plants between "batch" and "flow through" systems. Batch plants treat a measured quantity at a time, controlled by pump operation. This is advantageous in small systems to assure more complete treatment. Larger systems employ a continuous process and require frequent monitoring to assure good treatment.

6.251 Minimum Requirements: For those areas where waste water discharge is feasible only to a receiving water such as a river, lake, or the ocean, the Environmental Protection Agency has defined rigid guidelines controlling the quality of the effluent. These requirements are possible only through the use of a physical-chemical process or an extended aeration biological process. Student loads will define the minimum size (capacity) of "package treatment plants".

Either system requires a warm environment for proper functioning. Space allocation within the school proper is usually not adequate or isolated enough to provide sewage treatment. (See Section 4.3). Thus, an additional building immediately adjacent to the school is required. If a physical-chemical process is selected, storage for a full year's supply of chemicals is required. Surge tanks to control variable flow also require extra space.

6.252 Outfalls: Outfalls may be gravity or pumped and be located under the surface or supported above it. Insulation and provisions for thawing will be required in most instances. The end of the outfall must be designed to resist the forces of freezing and thawing, wind, and wave action. Exposure to the public (traffic, etc.) should also be a consideration.

Outfalls may require easements to reach a receiving water body. Permission from State and Federal agencies will be required before an outfall can be constructed.

6.253 Operation and Maintenance Requirements: Operation of physical-chemical plants requires a full-time operator. Fluctuations in flow and chemical characteristics require constant monitoring. Use of holding tanks can reduce the actual time spent by the operator, but will not reduce the personnel requirements to less than one person. Operation of extended aeration biological plants requires full-time maintenance upon start-up, and weekly maintenance thereafter. Use of a holding tank with metered flow to the primary treatment tank will prevent shockloading of the biological community. Such holding tanks may become offensive with odors when sewage is held too long and becomes septic. Aeration and/or agitation of holding tanks provides some relief of this problem by keeping the sewage organisms supplied with oxygen.

6.254 Codes: Title 18 of the Alaska Administrative Code, Chapter 72, Waste Water Disposal.

6.255 Relative Importance of Determinants: Figure 6.5 shows in tabular form the relative importance placed on various determinants as they effect the options available for waste water disposal systems for rural schools.

6.3 SOLID WASTE: Solid waste is that accumulation of refuse and debris, both man-made and natural, that requires some form of disposal. The collection and disposal of refuse from a school operation not only enhances the appearance of the school site, but reduces the chance of accidental fires and health hazards. It also keeps site drainage channels open.

6.31 Existing Sanitary Landfills: Most areas of Western Alaska utilize a natural depression in the ground as a landfill. Often, these depressions are not covered on a regular basis with dirt, thus allowing loose materials to scatter when the wind blows. As schools generate large amounts of paper, incineration prior to disposal at a landfill would reduce the quantities of paper, etc., that disperse whenever the wind blows. Use of household compactors for both burnables and nonburnables would also reduce the scatter effect. Determination of the existing system of collection of debris will assist in selection of a system of solid waste disposal.

If incineration is used as a supplementary form of refuse reduction, care must be taken to site the incineration unit, e.g., bunker, burn barrel, etc., a sufficient distance from any combustible structure so that wind-borne sparks will not endanger existing structures. Use of screens and baffles will further reduce the hazard from fire.

In those areas where incineration is unfeasible or not allowed by regulation, the use of covered garbage racks to reduce the spread of refuse by animals is highly desirable. All containers should have permanently hinged lids in order to reduce the spread of disease from flies and other insects.

WASTE WATER SUPPLY

FIGURE 6.5

Section 6.0 / Page 14a

DETERMINANTS / OPTIONS	Size of Facility	Water Source Availability	Power Available	Flooding	Permafrost	Climate	Maintenance Requirements	Cost	Technological Level	Treatment Requirements	Storage Requirements	0 = Unimportant 1 = Minor Importance 2 = Important 3 = Very Important COMMENTS
EXISTING:												
1. Piped System	2	3	2	2	3	2	2	2	2	1	2	
NEW:												
1. Treatment Plant	2	2	3	2	2	2	3	3	3	3	3	
2. Sewage Lagoon	2	2	2	3	3	3	2	2	2	2	3	
3. Septic Tank w/Soil Absorption	2	2	1	3	3	2	2	1	2	2	2	
4. Bunker System	2	1	0	2	2	2	1	1	1	1	0	

6.32 New Sanitary Landfill: In those areas which have no recognized system for refuse disposal, establishment of a site by school personnel is desirable. This site should be located in such a manner that contamination of groundwater supplies is avoided. In addition, the disposal site should be located so that air-blown materials will not impede aircraft or litter the village. Stockpiling of loose fill in the summer months will provide a supply of material that can be placed over the refuse to aid in both decomposition and visual aesthetics. Sanitary landfills should be located above the elevation of any known flooding.

6.4 ELECTRICAL POWER:

6.41 Commercial Power: Diesel-powered internal combustion generation is the only practical means of power generation in most rural areas, and is likely to remain so for some years to come. Supplemental power generation from wind machines is being experimented with in some locations in Alaska, but is not yet (and may never be) a replacement for diesel power. Small hydroelectric plants would be technically feasible at some sites, but usually require too much initial capital in relation to the small loads served to be considered.

Some support for a regional power system, as suggested by Robert W. Retherford's report "A Regional Electric Power System for the Lower Kuskokwim Vicinity", is being shown by the Alaska Energy Office. This scheme would interconnect several villages in the Bethel area with a relatively inexpensive high voltage transmission line, and would increase reliability of commercial power while lowering costs.

Nevertheless, the design consultant must be aware that "commercial power" in the bush means a system, where it exists, of generally poor performance and high cost. The consultant cannot assume that, just because commercial power exists, he may simply connect to the utility and ignore the consequences.

6.42 Commercial Power or On-site Generation: Whether to connect to commercial power or to provide 100% on-site generation should be decided on the basis of costs and convenience. The consultant should offer the owner a cost comparison between purchase of commercial power and operation of an on-site generator. The consultant should also evaluate the utility's reliability and performance, i.e., number and length of outages to be expected, voltage and frequency regulation, etc. On-site generation is discussed in more detail in Section 9.4.

6.43 Planning: If commercial power is to be used, the utility should be made aware of the anticipated load as early in planning as possible. Addition of school facilities will frequently increase the utility's load by 100% or more. No utility can be expected to absorb an increase of that magnitude without an opportunity to plan.

The consultant should furnish the utility with the following data:

1. An accurate estimate of peak load. Loads calculated from National Electrical Code requirements are seldom realistic and usually over-estimate actual peak loads by two or three times. AVEC (Alaska Village Electric Cooperative) can usually make an accurate estimate of their own when furnished floor plans and equipment lists.

2. Dates when construction is expected to begin and when the facility is expected to come "on line".

3. A list of the largest horsepower motor loads. Motor loads of five horsepower or more may be considered "large" by some utilities.

6.5 FUEL: (See also Section 9.121).

6.51 Minimum Requirements: Determine the amount of fuel to be stored at each location. Actual annual consumption, and method and frequency of transportation to the site, need to be established. It would in most cases be desirable to combine storage for electrical power generation and heating fuel in one location. Preferably, the tank farm will be located remote from the school and generator, with only day tankage near the buildings.

6.52 Tank Construction: Most fuel oil storage tanks in use today are of welded or bolted steel construction. It is envisioned that this will be true for all projects. Bladder-type tanks may be practical here or there for temporary storage. Great care must be taken to prevent physical damage and consequent fuel spills. Fiberglass tanks, while of superior quality, are generally more expensive than steel tanks.

Depending on site conditions, two methods should be investigated:

1. Provide the necessary storage capacity in one big storage tank.
2. Provide a specified number of smaller tanks.

The above does not preclude the usage of smaller "day tanks".

6.53 Application:

1. Large Tanks: The large tanks probably will be durably painted or galvanized. Plates and end pieces are bolted together at the site. Neoprene gaskets and bolt seal rings with recessed washers ensure tight connections. Most manufacturers of these tanks offer a racking system for shipping of tank components, thus minimizing space requirements on barge or aircraft. Obviously there is very little field piping, since only one tank needs to be connected.

For a composite structure, with one large central mechanical room for all fuel-burning equipment close to the others, the large bolted-steel tank may be an economical answer. However, a large single tank may require a larger dike capacity for spills than several small tanks because dike capacity requirements are based on the largest tank in the installation.

2. Small Tanks: For many years "nesting-type" cylindrical, vertical storage tanks have been a favorite in the North. They are also known as "AVEC" and "BIA" tanks. They come in capacities from approximately 5,000 gallons to 9,100 gallons. As the top of the tank is removable, they can be stacked together for easy shipping.

   These tanks are completely assembled and tested at the factory and require a minimum amount of erection time. Field piping, however, may be quite extensive. Swing joints, flex connections, and a liberal number of lockable shutoff valves are of utmost importance. These tanks can be used for either the "composite" layouts, or the "dispersed" system.

6.54 Installation: Tank elevation should be coordinated with building elevation. Gravity flow is desirable for various reasons.

A solid foundation must be provided. This is frequently accomplished by a gravel pad and heavy treated wood "sleepers".

The entire storage area must be diked in accordance with EPA rules and regulations. Membrane for the diked area must be suitable for extremely low ambient temperatures, resistant to the exposure to sunlight and petroleum products, and of long service life.

End of Section

7.0 Siting of Building Options

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SECTION 7.0 SITING OF BUILDINGS

7.1 MASTERPLANNING FOR GROWTH: A critical determinant in designing a successful educational facility is the evaluation of existing and future needs of the village. An evaluation should cover not only educational space requirements, but also utilities, e.g., sewer, water, solid waste, liquid waste, electrical power, fuel storage, and related distribution systems. This broadscope consideration achieves more efficient utilization of financial and human resources for construction, maintenance, and operation of the facility.

A "masterplan" should be developed to determine the best way to meet the above criteria, as well as to plan for orderly growth of the facility. The masterplan can minimize future costly relocation or duplication of utilities, as well as addressing the most feasible means for constructing additions to the educational facility.

An educational facility, with its media resource center, industrial education shops, multipurpose/gymnasium, etc., can be used for education during the day and serve community needs in the evening, on weekends, and holidays. (See Section 7.3).

New educational facilities often represents the largest capital investment in a village. In addition to providing education, it may provide water, power generation, and sewer utilities. Other buildings, such as a clinic or community meeting hall, could be located in the same general area and tie into the sewer, power, and water utilities needed by the school.

In some villages, there is potential to integrate the educational facility with new or existing community facilities to create a community education and service center within the village; in this planning concept, community facilities such as a health center, school, and laundry are located in close proximity to other buildings housing utility services (water, electricity, and sewage). This area of the village could become the center for community activities and a distribution point for services. Locating these community facilities and services close together could: 1) increase the potential for providing the most modern facilities; 2) lower construction costs; 3) reduce future maintenance and operation costs; and 4) increase the frequency of preventive maintenance.

Generally, the largest barrier to organizing this type of facility is coordinating the goals and schedules of contributing public agencies. The recently published "Waste Heat Capture Study", commissioned by the Department of Commerce and Economic Development, states, "If the various agencies (including AVEC) can begin thinking, planning, and operating as a unified group in designing and locating facilities, it is highly probably that fuel consumption in particular villages can be reduced by an amount equal to 25% of the fuel burned by the engine-generators."

7.11 Organizational Concepts: Conceptually, the spatial organization of the activity spaces and utility systems for an educational facility might be: 1) dispersed; 2) campus; 3) composite structures (complete, incremental); or 4) a combination.

7.111 Dispersed: Public facilities within a village have traditionally been laid out in a dispersed fashion. This is probably the easiest approach, because it requires the least coordination and planning. Typically, separate public agencies offer services from facilities remote from one another. Growth, too, of a facility generally results in a dispersed plan. Generator and cold storage buildings are often individual elements in all plans for reasons of fire safety, acoustics, and economics. (See Figure 7.1).

1. Advantages:

   a. Natural fire containment characteristics due to physical separation of buildings. This advantage is enhanced by special exterior fire-resistive construction and greater building separation distances.

   b. Acoustic isolation of activities is more easily achieved.

   c. Dispersed structures have good, relocatable potential for use elsewhere, and/or ease of direct future expansion of an adjacent structure.

2. Disadvantages:

   a. Maximum exterior surface area and extended or individual mechanical systems increase first and life costs.

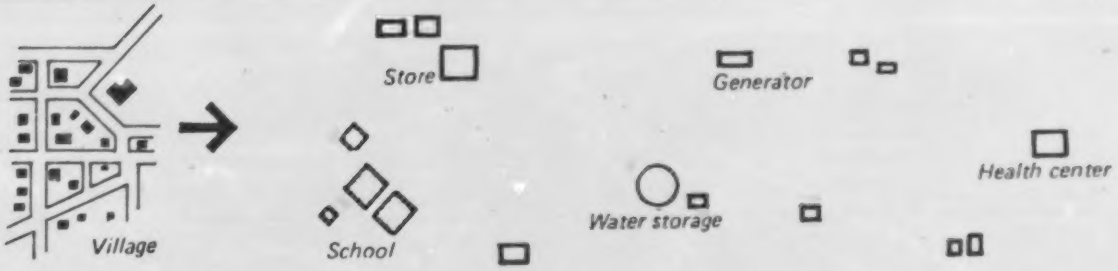
7.112 Campus: The campus plan is characterized by a series of independent buildings tied together by connecting corridors and utilidors. (See Figure 7.2).

1. Advantages:

   a. Natural fire containment characteristics based on physical separations between buildings. This feature is enhanced by special fire-resistive construction, greater separation distances, and special fire-resistive barriers at interfaces between buildings.

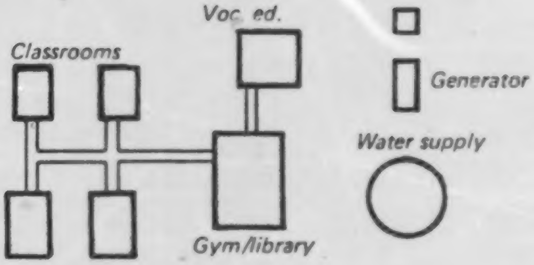
   b. Acoustic separation of activities is readily achieved.

   c. Buildings are connected by heated corridors for convenience of users.


Village
Store
Generator
Health center
Water storage
School

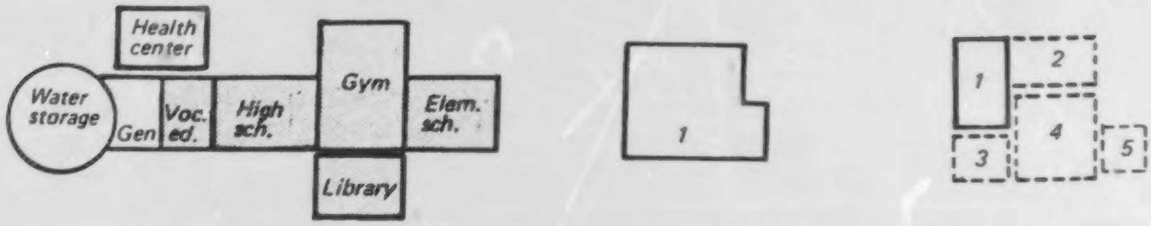
DISPERSED FACILITIES

(FIGURE 7.1)


Voc. ed.
Classrooms
Generator
Water supply
Gym/library

CAMPUS PLAN

(FIGURE 7.2)


Health center
Water storage
Gen
Voc. ed.
High sch.
Gym
Elem. sch.
Library
1
1
2
3
4
5

A. TYPICAL COMPOSITE STRUCTURE

B. COMPLETE

C. INCOMPLETE

(FIGURE 7.3)

2. Disadvantages:

   a. A high percentage of area is devoted to circulation.

   b. Greater exterior surface area increases heat loss, exterior maintenance, and first and life costs.

   c. Utility runs between buildings must be protected in heated enclosures (utilidors), increasing first and life costs.

   d. Prone to problems associated with differential settlement.

7.113 Composite Structure: The composite structure is characterized by all activities being contained in one structure. (See Figure 7.3A).

1. Types:

   a. Complete Composite Structure: The structure would be built entirely in one phase, which could decrease construction costs. Larger facilities necessitate greater importation of outside labor and reduce the construction period. (See Figure 7.3B).

   b. Incremental Composite Structure: This type of structure would be completed in a series of phases, with a core facility provided in the initial phase, and an additional facility constructed sequentially in the following year (this also provides a source of local employment over a greater period of time). (See Figure 7.3C).

2. Advantages:

   a. Reduces the amount of exterior wall and circulation area. Enhances the amount of usable area and the efficiency of mechanical systems (generation and distribution).

   b. Should provide the lowest possible operation and maintenance costs of the three organizational concepts. The quality of maintenance and operation should also improve since maintenance resources and utilities can be more centralized, and thus more accessible to service.

3. Disadvantages:

   a. Containment of fire to special areas in the composite building requires fire-resistive barriers and/or fire protection equipment systems which add to first and life costs.

b. The composite structure is difficult, if not impossible, to move, versus dispersed and campus plans which allow easier relocation of individual buildings.

c. Requires future growth, planning, coordination, and cooperation from different public agencies.

7.114 Combination: Most facilities presently have existing structures that can be used as part of a new facility. The combination plan allows for the attachment of a new core facility to existing structures. (See Figure 7.4A, and 7.4B).

1. Use: New secondary school could be attached to existing primary school and share common program areas (multipurpose, cafeteria, kitchen, playdecks, etc.).

2. Advantages:

a. Potential first and life cost savings due to sharing spaces and utilities.

b. Single facility for a more cohesive relationship to the community.

3. Disadvantages:

a. The cost of incorporating existing facilities may not be cost-effective due to requirements for upgrading to meet code, utility, and fire safety criteria compatible with new facilities.

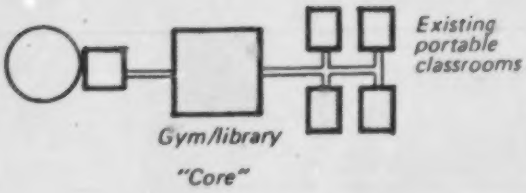
b. Problems associated with integrated secondary-primary facility.

7.12 Evaluation of Masterplanning Concepts: To evaluate masterplanning concepts, the organization of these elements should be reviewed in light of the following topics:

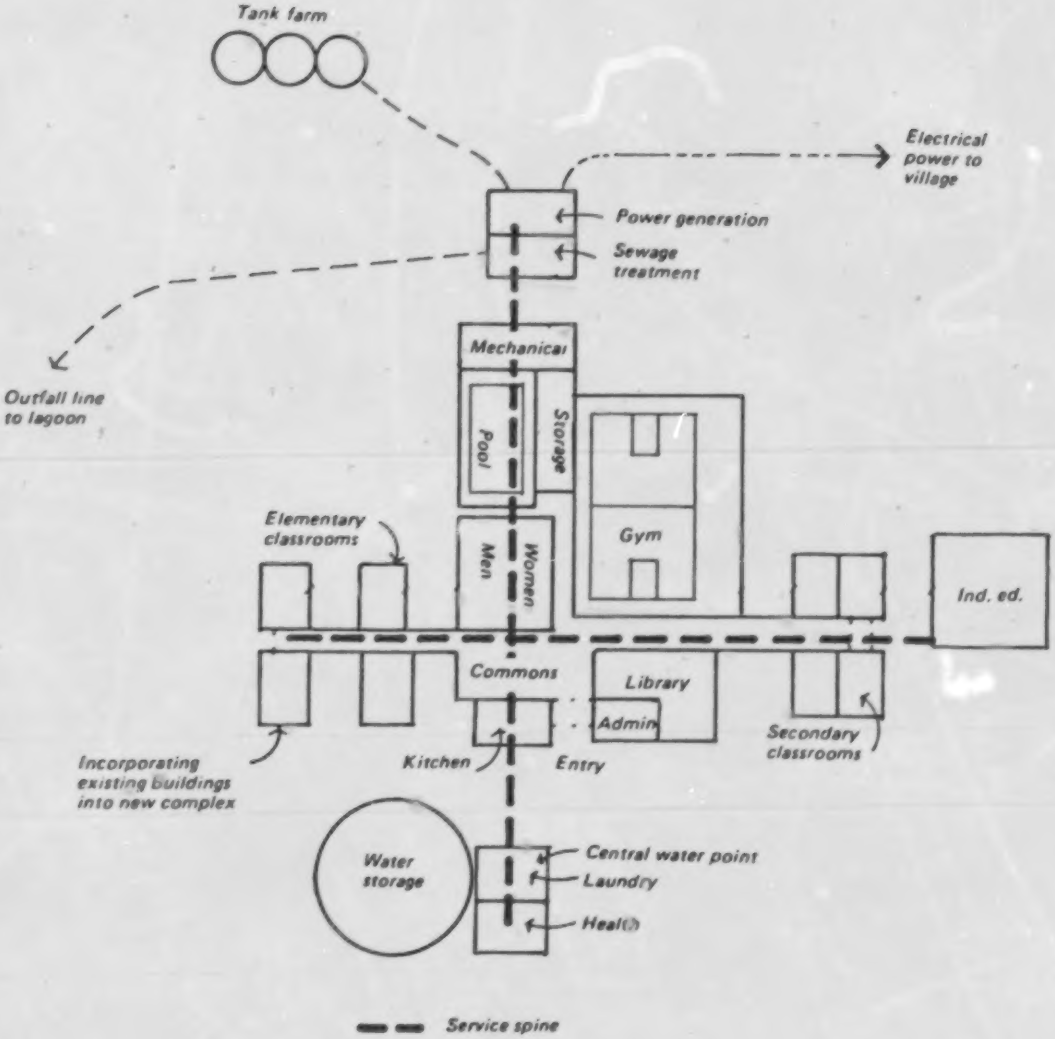
7.121 Climate and Topography: Local environmental conditions must be taken into account; these include prevailing winds, snowdrift potential, sun, drainage, flooding, etc. (See Section 7.2).

7.122 Maintenance and Operation: Buildings should be designed to maximize accessibility and use of built space.

7.123 Agencies Involved: What are the realities and trade-offs in terms of coordinating the required agencies to acquire funding, approvals, and initial capital and operating funds for combined facilities?


Existing
portable
classrooms
Gym/library
"Core"

A.COMBINATION FACILITY


Tank farm
Electrical
power to
village
Power generation
Sewage
treatment
Outfall line
to lagoon
Mechanical
Pool
Storage
Gym
Elementary
classrooms
Men
Women
Ind. ed.
Commons
Library
Admin
Secondary
classrooms
Incorporating
existing buildings
into new complex
Kitchen
Entry
Water
storage
Central water point
Laundry
Health
Service spine

B. AN EXAMPLE PLAN: A COMBINATION EDUCATION AND COMMUNITY FACILITY FOR A LARGE ARCTIC COMMUNITY. (NORTH SLOPE BOROUGH STANDARDIZATION STUDY, 1978)

(FIGURE 7.4)

7.124 Fire Prevention and Protection Plan: Is there a plan for fire prevention and protection, i.e., water available (storage) for sprinkler systems, building and combustible building link and playdeck separations, etc.? (See Section 5.3).

7.125 Adaptation to Existing Facilities: It is difficult to add on to a school owned and operated by BIA because of separate ownership and operation. How does the design integrate with existing facilities and environs? Is integration or connection economical if the existing facility requires code upgrading?

7.126 Constructability:

1. Local Hire: Assess local labor force. Does the design afford utilization of local labor as available? There is a limited amount of local labor available at a given time. Proper scheduling of projects may increase the demand for labor beyond local potential, causing a greater importation of outside labor, thus raising costs for imported labor, travel, and lodging.
2. Time: Will the amount of time required to build the project affect the design?
3. Logistics: Will the time of year and method of shipping materials to site affect the design, specifications, and detailing? (See Section 2.3).
4. Common Materials: It is desirable to minimize the number of materials on the job and avoid exotic materials and detailing.
5. Local Technology: In maximizing local hire, the technology of a given project must complement the level of technology in that particular village.

7.127 Utilities:

1. Existing: Consider distances, quality, quantity, reliability.
2. New: Location with relation to new facility, existing facility, fuel storage, water source, waste disposal, paths, trails, roads, village, transportation terminus.

7.128 Scale Relationships: The secondary school may be the largest structure in the village. The designer must recognize this transition in the massing, design of entries, fenestration, and utilization of materials. How can the aesthetic design contribute to the idea of a secondary school becoming an integral part of the community? (See Section 7.3).

7.2 SITE SELECTION AND MODIFICATION: Site selection is often dictated by existing man-made constraints, such as community layout, location of the old school, utilities, houses, and whether and where various types of expansion are likely to occur. Within these constraints, sites are often selected which present environmental hazards. If these can be avoided, site work can be simplified. The satisfactory trade-off between social and natural restrictions is a decision to be made for each school. For the conditions of a given site, further design and site modifications can be made to improve the function of the school building.

7.21 Environmental Constraints: These are dictated by topography and climate. They include flooding, erosion, high winds, drifting snow, permafrost, poorly drained organic or fine grained foundation soils, seismic activity, etc. Although the climate of Western Alaska is not uniform, it is more consistent over the area than is the topography. In either case, local conditions can greatly emphasize certain effects, and topography is the more tractable of these two environmental constraints.

7.211 Topography: Foremost among environmental site criteria are those things generally grouped under topography: good surface drainage; wind and sunscreening; cold air flow; public accessibility under icy, foggy, snowy and slippery conditions; avalanche and landslide hazard; and flooding potential. Most of these are discussed individually below. In general, though, topographical considerations strive to place the building in a level, well-drained area with a favorable microclimate. Upwind berms and large foliage provide windbreaks, and south-facing slopes provide sunlight and warmer conditions. Sites in ravines or valleys are typically cold due to heat flowing upward, and more susceptible to fogged-in conditions. Sites on steep slopes can be dangerous when icy for people and machines, and are more exposed to storms and wind.

7.212 Flood Plain: Building out of the flood plain, where possible, is an obvious primary consideration. It should be evaluated first even though social factors may dictate otherwise. If a low site is chosen, however, there are several design options:

1. Evaluation of Hazard:

   a. Flood potential may typically be obtained from various governmental agencies, such as the U.S. Army Corps of Engineers, and discussions with local residents. Long-range plans for moving entire villages can be used or incorporated into building site selection, especially in regard to the flood plain.

   b. The degree of flooding is also a consideration. Wind-driven storms or fast-moving high waters in a channeled flood plain are a real threat, but low flooding over a wide area to a depth of one to two feet can be accommodated in design.

2. Alternatives:

   a. A structural fill of compacted gravel two to four feet thick can raise the building enough, on flat terrain, to make it a flood haven for the area. This requires a source of gravel, equipment with which to move it, and compaction machinery.

   b. Elevate structure on piling foundation system.

   c. Flood protection can be afforded by diking the site. This method, while relatively common, has numerous drawbacks: erosion of the dike by flood waters, infiltration of flood waters under or through the dike, and hydraulic pressure collapsing basement or foundation walls. Protection from tidal and storm action is provided by breakwaters, sheetpiling, and/or diking, which experience the same drawbacks. Adequate protection from flooding by these systems requires a massive construction effort, often outside the economic range of school construction.

7.213 Erosive Forces: Erosive forces must be considered over the life of the building. These include riverbank and coastal erosion, as well as avalanching, landslides, creep, and solifluction.

1. Evaluation of Hazard:

   a. Local residents can offer a wealth of information on such conditions. Examination of slopes, wind patterns, existing soil types, vegetative patterns, and historical photos can all help in identifying erosive situations.

2. Alternatives:

   a. First consideration would be to select a site far enough back from the water or high enough to avoid landslides or avalanches. Where hazards have been identified and cannot be avoided, site modifications can include those mentioned for flood control for coastal and bank erosion.

   b. Landsliding can be relieved by slope drainage and retaining walls. Creep and solifluction can be retarded by restoring the vegetative mat. Care must be taken during construction not to accelerate or create landslide conditions by undercutting natural embankments or vegetation, or diverting water in such a manner as to raise the water table or increase runoff.

7.214 Wind and Snowdrifting: These forces, in conjunction with site topography, affect building orientation, foundation and roof design, and entrance location. Sites leeward of buildings, ridges, or tall trees are susceptible to drifting conditions and should be avoided in the first place if possible. On the other hand, if drifting is not a local problem, these same conditions may offer wind protection. (See Figure 7.5).

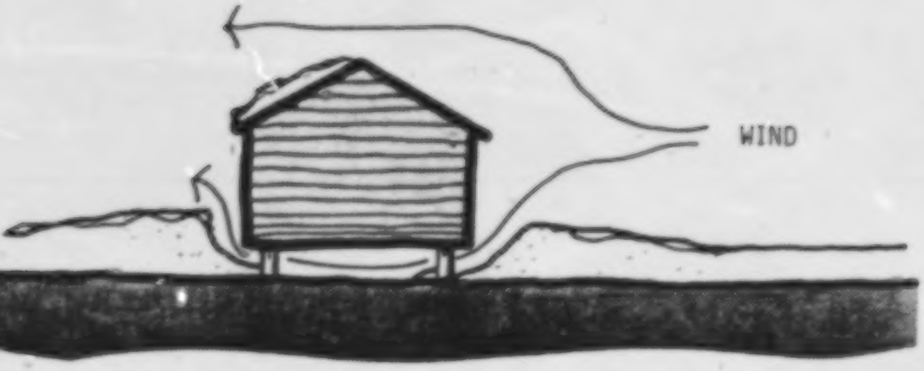
1. Protection Against Hazards:

   a. Wind and snow records from the weather service, FAA and other sources, wintertime aerial photos, and local knowledge of existing drifting patterns can help in the design to avoid snowdrifting about entrances and within the breezeway and access routes. Care can be taken to minimize the effects of strong or gusty winds on the structure.

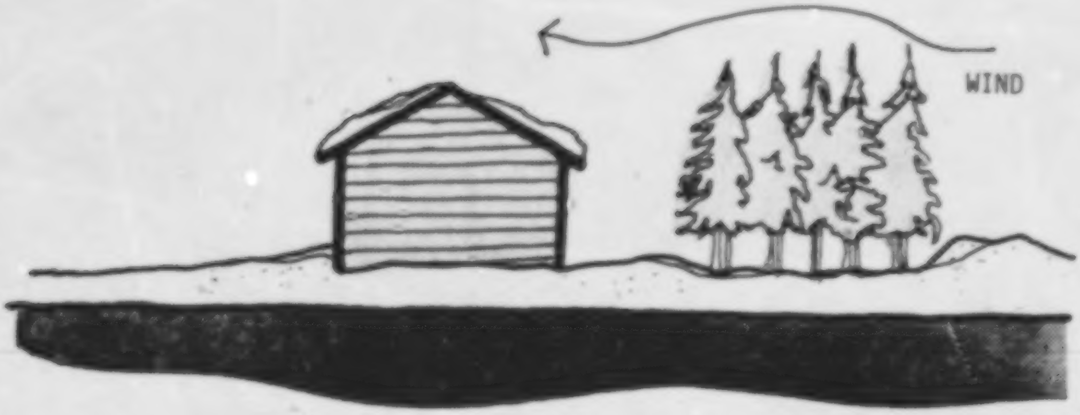
2. Alternatives:

   a. In locations with strong wind patterns, doors must be situated so that they are sheltered from direct wind, which can make doors difficult to open or close. Sometimes an entry on the prevailing wind side of a building will cause pressurization within the building when the door is open, thus causing other exterior doors to be blown open and creating a direct draft through the building. Care should be taken when designing a through-building corridor plan with exits at each end, so that if the prevailing wind direction is parallel to the corridor, the wind will not be allowed to blow through the building in this manner. (See Figure 7.6).

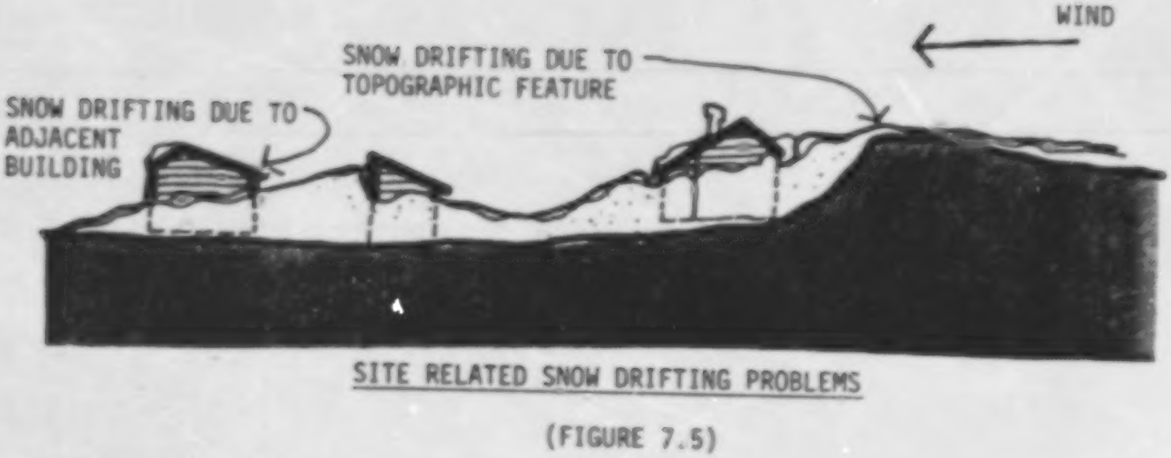
   b. Care should also be taken so drifting snow will not block doors shut, creating serious life safety problems (exiting). Alignment of the school building with other buildings, topographic features, and trees can either slow down or accelerate windflow, thus affecting the size of potential snowdrifts. (See Figure 7.5). De-accelerating the wind-borne snow causes it to settle and drift; accelerating the wind-borne snow tends to carry the snow along and reduces drift size. Thus, raising a building and creating an open space beneath will cause the wind to accelerate under the building. This carries the snow under the building and tends to clear the far side of snow. By keeping the underbuilding space clear of snowdrifts and their insulating qualities, the permafrost regime can be preserved.



WIND SCOUR UNDER RAISED BUILDING



VEGETATION PROTECTING BUILDING FROM WIND


WIND
SNOW DRIFTING DUE TO TOPOGRAPHIC FEATURE
SNOW DRIFTING DUE TO ADJACENT BUILDING

SITE RELATED SNOW DRIFTING PROBLEMS

(FIGURE 7.5)

POOR:

WIND CAN BLOW DOORS OPEN.

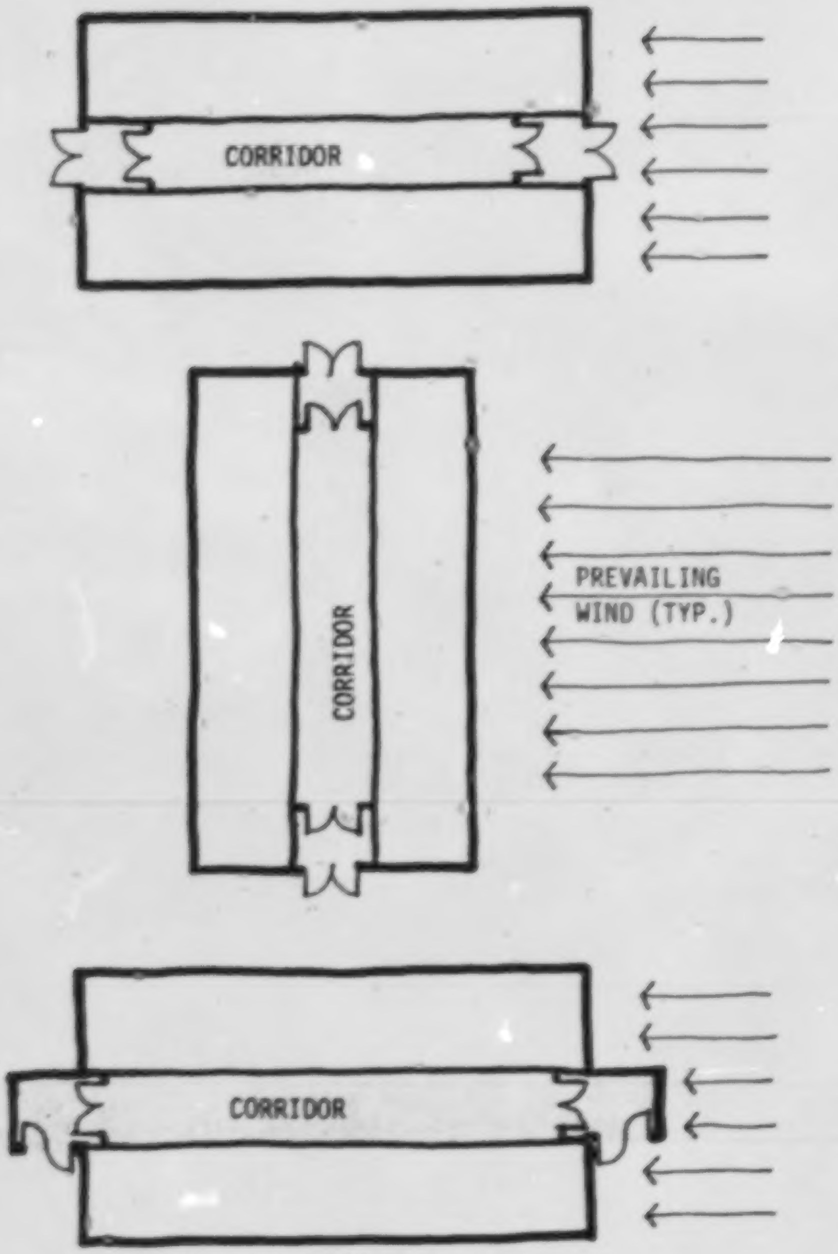
BETTER:

WIND CAN MAKE DOORS DIFFICULT TO OPEN OR CLOSE.

BEST:

WITH ADDITIONAL INSWINGING DOORS FOR UNUSUAL DRIFT PROBLEMS.

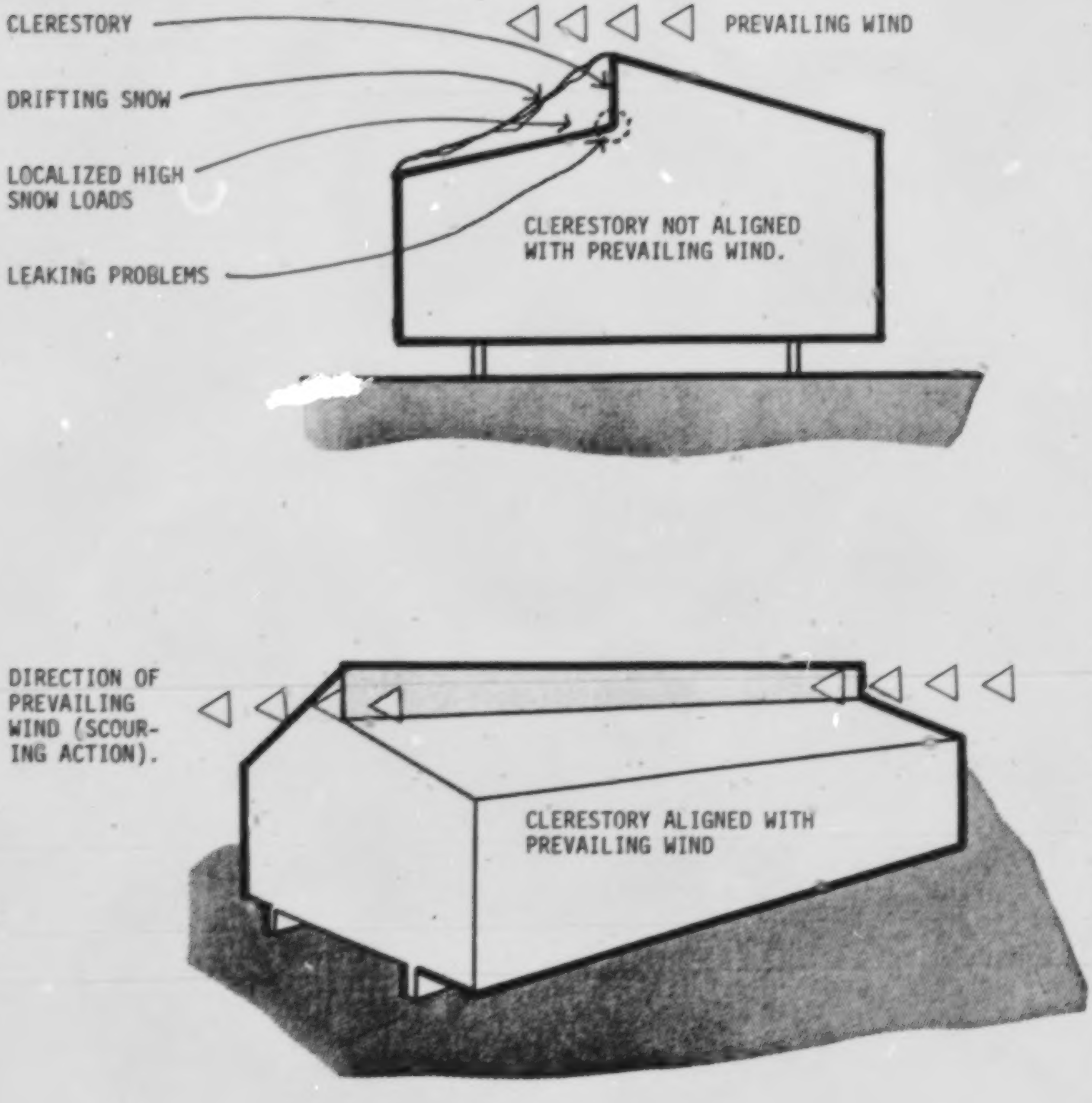
(ASSUMES THAT BUILDING IS ELEVATED, MINIMIZING SNOW DRIFTING ON LEEWARD SIDE.)


CORRIDOR
CORRIDOR
PREVAILING WIND (TYP.)
CORRIDOR

TYPICAL CLASSROOM BUILDINGS

CORRIDOR LAYOUT

(FIGURE 7.6)


CLERESTORY
PREVAILING WIND
DRIFTING SNOW
LOCALIZED HIGH SNOW LOADS
LEAKING PROBLEMS
CLERESTORY NOT ALIGNED WITH PREVAILING WIND.
DIRECTION OF PREVAILING WIND (SCOURING ACTION).
CLERESTORY ALIGNED WITH PREVAILING WIND

BROKEN PITCHED ROOF
(FIGURE 7.7)

c. Orientation of the narrowest building wall perpendicular to the prevailing wind can reduce wind load, wind and snow infiltration, and snowdrift area size. Wind protection to the building can be afforded by drift barriers as mentioned above. When the building is higher than the barriers, it will be subject to increased wind pressures.

d. Roof design can also reduce or promote drifting. Clerestores and notched ridge roofs can collect large quantities of drifting snow, causing high localized snow loading conditions (potentially exceeding the average snow load design requirements by over 100%) and creating structural, venting, and moisture penetration problems. (See Figure 7.7).

7.215 Seismicity: Proximity to faults and the potential for earthquakes are significant influences on structural design. Avoidance of unstable sites is an obvious imperative. (See also Section 2.214).

1. Evaluation of Hazard:

a. USGS reports and maps can be helpful, as well as local reports of historical activity.

2. Alternatives:

a. Once the site is chosen, only structural and earthwork changes can be made. Foundation connections, shear walls, lateral bracing, roof connections, and facade details are all critically important in areas of higher earthquake risk; both proper design and construction techniques are imperative for building and occupant safety.

7.216 Sun: It is desirable to orient windows and play areas to maximize sun exposure. However, the low sun angle in the winter may cause glare as well as heat-gain problems inside the building unless provisions are made for adjustable shading on glazed areas. South-facing exposures for academic areas is desirable to take advantage of as much sunlight as possible during the school year.

7.3 ORIENTATION TO COMMUNITY: Schools play an important role in the community, particularly those facilities that are used for community activities such as evening classes, meetings, athletic events, and social gatherings. Integration into the physical fabric of the community facilitates community interest and use of the school.

7.31 Existing Paths and Roads: Existing paths and roads, both seasonal and permanent, need to be identified to provide convenient, safe access, connecting the school with well-traveled paths to and from homes and community facilities and businesses. A close and easily accessible school may have a different impact on the villagers' perception of the facility than a distant, isolated or poorly oriented site.

7.32 Existing Community Facilities: School facilities that are used for community activities could intensify the community focus. Also the potential exists for sharing utilities, equipment and spaces, both inside the building and out. A school situated in close proximity to other public and private facilities such as post offices, stores, health clinics, communications facilities, etc., can increase the potential for daily interaction between villagers of all ages and the school staff, thus reinforcing educational relationships. (See also Section 7.1).

7.33 Existing Housing: School facilities adjacent to housing provide convenient access for children in the daytime and adults in the evening. It also allows for any indoor or outdoor recreational space to be more fully utilized, and creates a potential to share utilities and certain facilities like shops, laundry, and home science equipment.

7.34 Use of Materials: Schools are frequently the largest facility in a village. Use of new or familiar materials, the quality of materials, and the detailing create an image of the facility that affects its qualities of permanence and relationship to existing values and technology. The school is traditionally one of the first institutions in the village (along with churches and the post office); as such, it also reinforces the permanence and longevity of that institution and the community. Thus, consideration must be given to the selection of materials, siting, and the visual statement the building will make in the community.

7.35 Outside Amenities: School facilities should provide elevated walks and playdeck space wherever site conditions include wet ground. Decks should receive good winter sun (south) exposure and protection from wind. Wind protection of the deck may be afforded by siting of the building and the use of surrounding buildings and topography to create a windbreak. Playdecks can be integrated into broad entry steps. Ramps should be oriented for easy access from roads, paths, etc. Other considerations are lighting of paths and entries, location of paths, ramps, and entries with relation to roof runoff, and location of aboveground utilities so as not to obstruct site circulation.

7.4 SITE MODIFICATIONS:

7.41 Drainage: During spring thaw, melting snow and frozen soil create a mire in areas stripped of vegetation, vehicular and pedestrian traffic areas, and construction sites. A gravel pad sloped to drain is generally recommended in low-lying areas where gravel can be obtained. This pad provides a dry surface for use in construction and material stockpiling and, upon building completion, provides a water-free area for playing and walking. If properly designed, it can also reduce snowdrifting, reduce flooding potential by elevating the building, and add an insulating layer to maintain a permafrost regime.

On sloping sites, a certain rerouting of the natural (existing) drainage may be required, whether a pad is put down or not, to reduce water infiltration around foundations, which may result in frost heaving or degradation of the thermal regime. The use of silty or fine-grained backfill around foundations can also reduce this infiltration.

7.42 Excavation: Excavation and clearing require heavy machinery. In sites where the vegetation is a thick, continuous mat underlain by permafrost, excavation, clearing, or even travel across it can adversely affect the frozen condition. Travel by tracked or wheeled vehicles should be limited, as well as the extent of clearing for the building site. Replacing or modifying the disturbed areas is imperative. Improper excavation can also disrupt drainage, causing erosion or permafrost melting and damage to other structures. Planning the type of equipment, as well as the time of year that it is transported and used at the site, is critical in maintaining stable soil conditions as well as for aesthetic reasons. (See Section 2.212).

End of Section

8.0 Building Envelope options

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SECTION 8.0 BUILDING ENVELOPE AND STRUCTURE

INTRODUCTION:

The arctic environment imposes hardship upon a building's envelope and structure beyond the conventional technology of more temperate climates. Design of systems that can perform under the environmental conditions identified in this report is a serious and difficult task. Our solutions find their basis in the technology developed for the most part in a more temperate environment. The envelope must resist weather, heat transfer, and vapor transfer that stress conventional solutions to their extreme. Frequently, the structure must resist additional forces caused by unstable soil conditions far worse than those commonly found in warmer climates. We have assembled below a range of options that are considered recommended solutions to the environmental conditions encountered within the study area.

8.1 SOILS: Prior to foundation design, knowledge of subsurface conditions on-site must be obtained. Soil type, water table depth, permafrost, ice lensing, surface and subsurface drainage, and depth of active layer are all properties used in the design of foundations, excavation, drainage, and landscaping.

8.11 Evaluation of Conditions: Visual inspection of site(s) should be made to evaluate flood potential, slide hazard, drainage patterns, peat deposits and rock outcroppings, evidence of ice lensing, ice wedge polygons, and erosion potential.

Subsurface investigation, due to the expense, is normally undertaken after the range of sites has been reduced. Site conditions, anticipated foundation type, and cost dictates types of exploration performed. Site and transportation conditions determine whether work will be performed during winter while the site is frozen, or during summer when the site is thawed. Best performance of men and equipment is obtained during warm weather, but travel on the site may be impossible once it is thawed. Foundation type influences depth of exploration with piling requiring the deepest work and potentially less depth with conventional shallow footings.

8.111 Test Pit Exploration: Ranges from pick and shovel to backhoe and cat excavation, with exploration depths varying from a few feet to 15-20 feet, depending on equipment size and soil.

1. Advantages:

   a. Use of on-site labor and equipment reduces transportation costs and enhances training of local people who may be available to perform additional exploration at a later date.

2. Disadvantages:

   a. Exploration to insufficient depth, or on-site equipment of insufficient size for exploration requirements.

   b. Difficulty in determining densities and potential disrupting of material under future footings.

8.112 Augered Test Holes: Augered test holes, with depth of holes and sampling techniques, is related to the type of soil encountered and equipment size. If pilings are contemplated, this method is generally the only way to obtain sufficient subsurface information.

1. Advantages:

   a. Ability to obtain undisturbed samples and determine subsurface densities.

   b. Provides greater site coverage with minimal site disturbance.

2. Disadvantages:

   a. Importing trained labor and equipment.

   b. Robust drilling equipment will require relatively large transportation carriers which may mean winter operation due to airport limitations.

   c. Cost of transportation.

   d. Inability to do follow-up exploration once equipment is removed from site.

8.2 FOUNDATION SYSTEMS: Foundation systems range from conventional shallow spread footings to sophisticated freeze-back piling. The systems and their general applicability include:

8.21 Shallow Spread Footings: (See Figures 8.1, and 8.2).

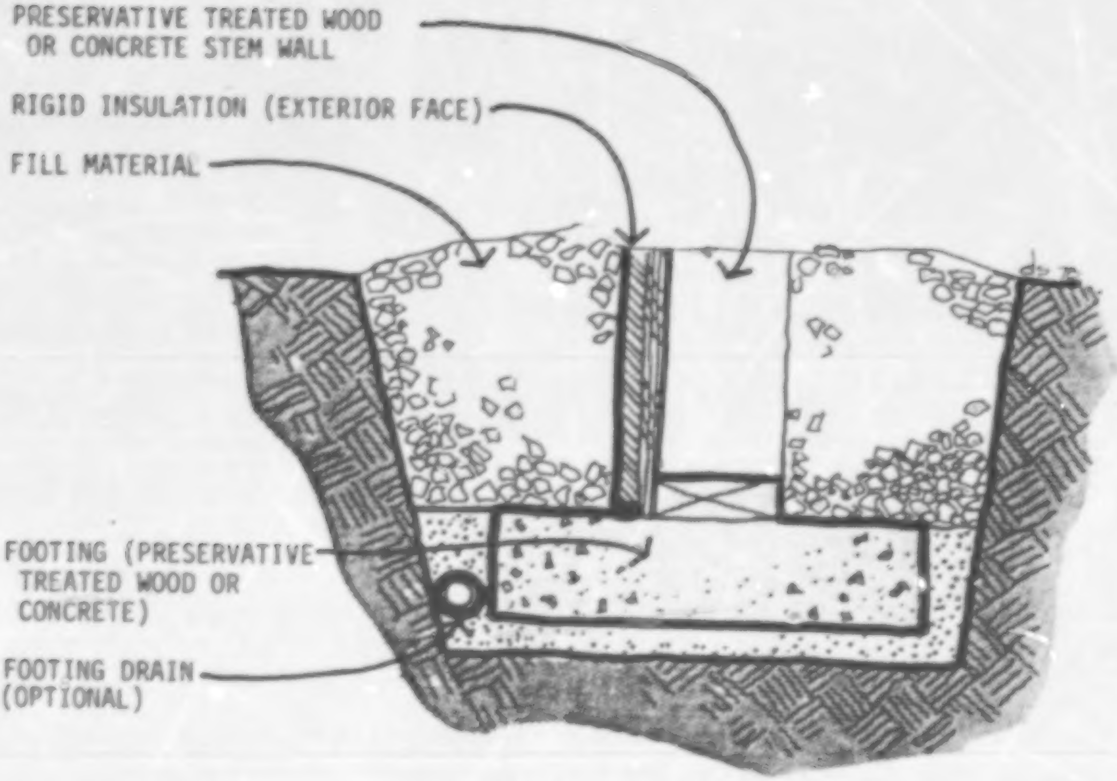
1. Applicability: Depending on type, can be placed on thawed soil or permafrost (well-drained gravel). They perform well on bedrock, free-draining gravel, or sand.

8.211 Conventional - Portland Cement Concrete (P.C.C.):

1. Advantages:

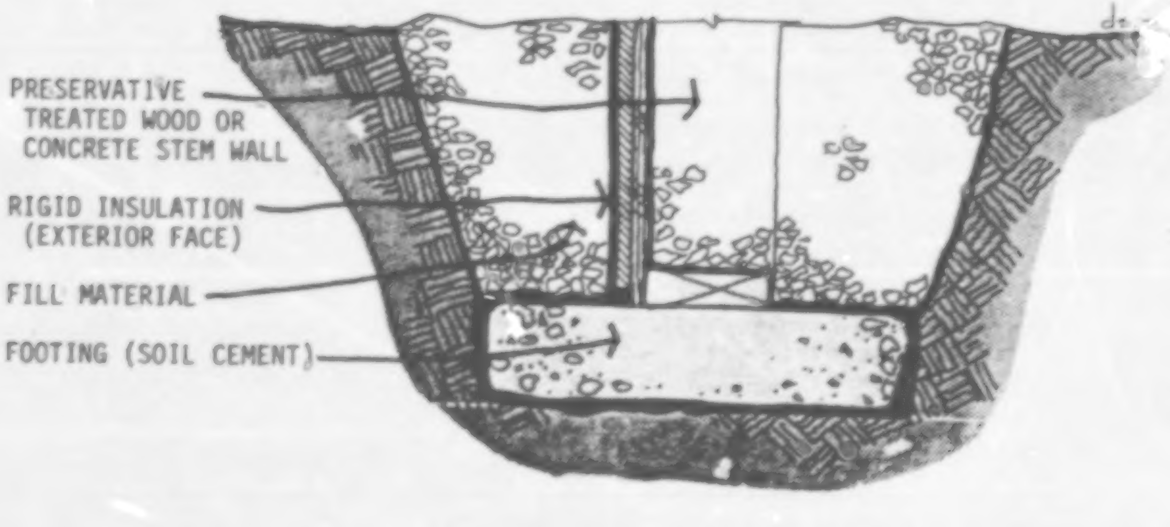
   a. Common construction techniques applicable to local labor.

   b. Requires equipment and materials readily available and transportable by surface or air.


PRESERVATIVE TREATED WOOD OR CONCRETE STEM WALL
RIGID INSULATION (EXTERIOR FACE)
FILL MATERIAL
FOOTING (PRESERVATIVE TREATED WOOD OR CONCRETE)
FOOTING DRAIN (OPTIONAL)

CONVENTIONAL SHALLOW SPREAD FOOTING

FIGURE 8.1


PRESERVATIVE TREATED WOOD OR CONCRETE STEM WALL
RIGID INSULATION (EXTERIOR FACE)
FILL MATERIAL
FOOTING (SOIL CEMENT)

SHALLOW SPREAD FOOTING - SOIL CEMENT

FIGURE 8.2

2. Disadvantages:

   a. Requires a source of portland cement concrete (P.C.C.) aggregate, processing, mixing, batching equipment, and an abundance of uncontamined water.

   b. Requires thawed and stable foundation soils; large structures often affect deep soils; thus, it must be confirmed that soils up to 100 feet are thawed or will not be affected.

   c. Requires temperatures above freezing for setting and curing, unless precast is employed which generally is too heavy and bulky to be feasibly transported.

8.212 Conventional - Treated Wood:

1. Advantages:

   a. Does not require source of P.C.C. aggregate or salt-free water.

   b. Simple construction techniques applicable to local hire.

   c. Can be used with P.C.C. treated foundation soil.

   d. Requires equipment and materials readily available and transportable by surface or air.

2. Disadvantages:

   a. Requires thawed and stable foundation soils; large structures often affect deep soil; thus, it must be confirmed that soils up to 100 feet are thawed or will not be affected.

8.213 Post and Pad: (See Figures 8.3, and 8.4).

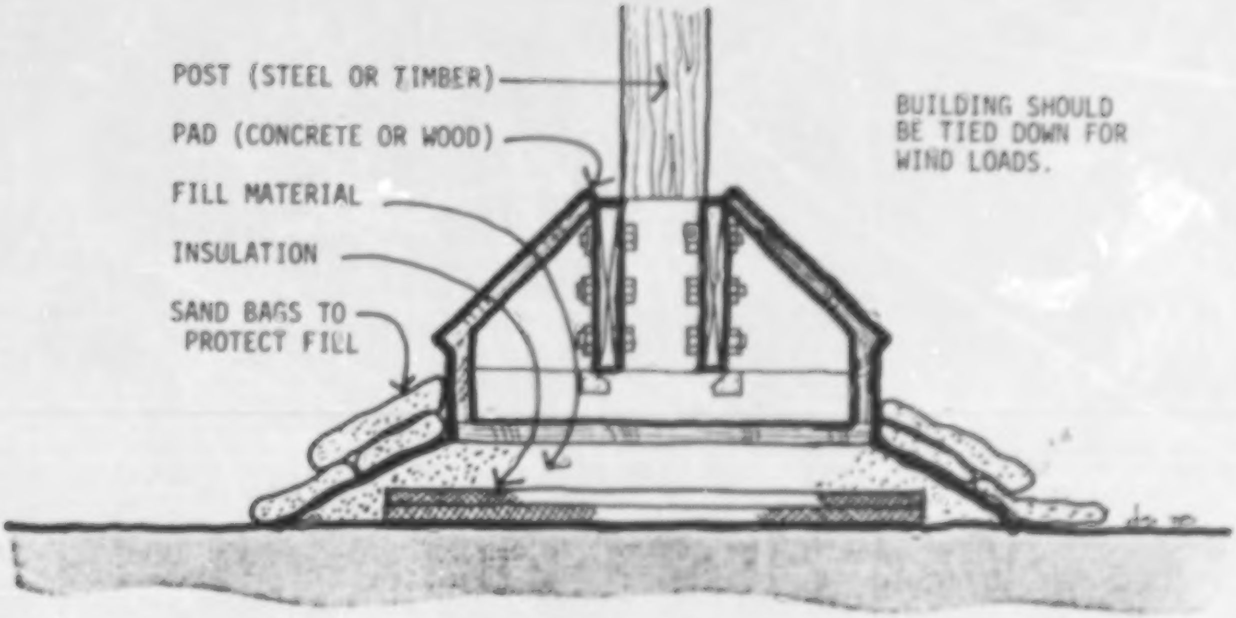
1. Advantages:

   a. Can be used in aggrading permafrost as well as thawed soils.

   b. Can be used to provide breezeway under buildings to promote or retain permafrost, and to raise the building above water during flooding.

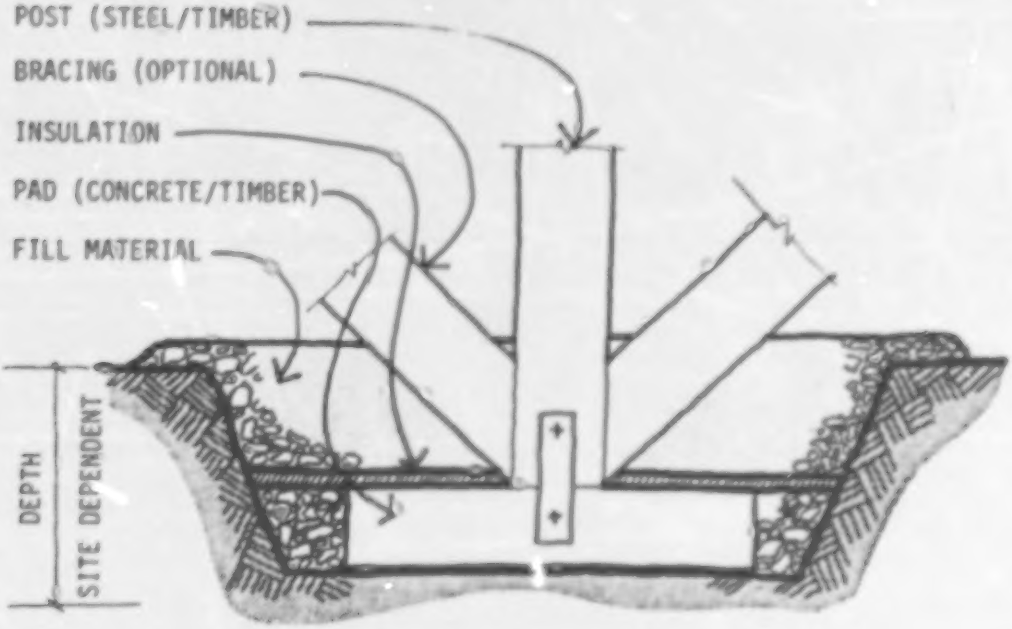
2. Disadvantages:

   a. Generally requires a source of nonfrost susceptible (NFS) soil or aggregate for pad and equipment for moving and handling the soil.


POST (STEEL OR TIMBER)
PAD (CONCRETE OR WOOD)
FILL MATERIAL
INSULATION
SAND BAGS TO PROTECT FILL
BUILDING SHOULD BE TIED DOWN FOR WIND LOADS.

POST AND PAD

FIGURE 8.3


POST (STEEL/TIMBER)
BRACING (OPTIONAL)
INSULATION
PAD (CONCRETE/TIMBER)
FILL MATERIAL
DEPTH
SITE DEPENDENT

POST AND PAD

FIGURE 8.4

8.214 Mud Sills:

1. Advantages:

   a. Uses conventional "wood frame" construction techniques.

   b. POL (Petroleum, Oil, Lubricants) tanks and other small storage structures perform well with this system.

   c. Can be used on permafrost as well as thawed soil.

   d. Generally very low initial cost.

2. Disadvantages:

   a. Susceptible to volume change in foundation soils.

   b. Requires insulation and NFS soil for four feet or thicker pad. The pad requirements depend on structure size and heat transfer.

8.215 Slab-on-Grade:

1. Advantages:

   a. Common construction techniques applicable to local labor.

   b. Requires equipment and materials readily available and transportable by surface or air.

2. Disadvantages:

   a. Requires source of P.C.C. aggregate, processing, mixing, batching equipment, and an abundance of uncontaminated water.

   b. Requires thawed soils to a depth in excess of 100 feet under heated structures.

   c. Generally requires structural fill as a base.

   d. Requires temperatures above freezing for setting and curing an enclosure and heating systems.

8.22 Piles:

1. Applicability: Driven piling are used to penetrate a soft, unstable soil to firm bearing in a more or less incompressible soil. They can be used in frozen or unfrozen ground. The areas of permafrost may be very hard and require special driving techniques.

Generally, augered pilings gain their strength by friction due to adfreeze of the slurry surrounding the pile. Augered piling with subsequent freeze-back requires equipment of sufficient size to drill holes to the required depth, and a means to actively freeze-back the pile or sufficiently cold ground temperatures for freeze-back to occur naturally. (See Figures 8.5, and 8.6).

8.221 Driven Piles: Pile driving equipment (diesel and steam hammers) has been used successfully, though diesel units have problems in very cold weather. Vibrating hammers have great promise and have done exceptionally well with pipe piles in frozen silts. In all cases, a great deal of energy is necessary to cut/melt frozen soils. Some vibratory systems tend to develop a great deal of energy at the cutting shoe, and effectively melt the permafrost rapidly at this point. In thawed soils, the driving is conventional. Driven piling requires a driving hammer, leads, and a crane to hold the leads over the pile point. The crane can be useful for other construction activities besides piling. (See Figure 8.5D.).

WOOD:

1. Advantages:
   a. Conventional driving techniques in thawed soils.
2. Disadvantages:
   a. Thawed soils only.
   b. Special labor and equipment requirements.
   c. Difficult to add additional lengths.

STEEL PIPE PILE, HEAVY WALLED:

1. Advantages:
   a. Satisfactory in most soils (frozen or thawed).
   b. Relatively simple to lengthen pile in the field.
   c. Ability to add freeze-back system after pile installation.
2. Disadvantages:
   a. Pipe section and hammer must be selected to overcome frozen soil resistance in frozen soils.
   b. Special equipment and labor requirements.

STEEL "H" SECTIONS:

1. Advantages:

   a. Frozen or thawed soils.

   b. Minimum of disturbance to frozen soils.

   c. Relatively simple to add additional lengths in field.

2. Disadvantages:

   a. Require strengthened steel webs; See CREEPA 1976 Reports.

   b. Sophisticated pile driving system.

PRECAST CONCRETE: (Not recommended).

8.222 Augered Piles: Drilling equipment for augered piling requires sufficient size to drill holes of diameter and depth as specified. Freeze-back systems, whether active or passive, require sufficiently cold temperatures to maintain the frozen slurry around the pile. Insulation of the floor of the supported structure is critical, and a breezeway (three foot high minimum) is recommended to further protect the piling from thawing. The slurry should be a mixture of water and sand/silt with the consistency of lean concrete. Cuttings from the auger's hole will usually serve for slurry unless organic or gravelly, in which case, sand should be imported. (See Figures 8.5A., 8.5B, 8.5C, and Figure 8.6A).

WOOD:

1. Advantages:

   a. Active freeze-back system can be placed at the time of installation.

2. Disadvantages:

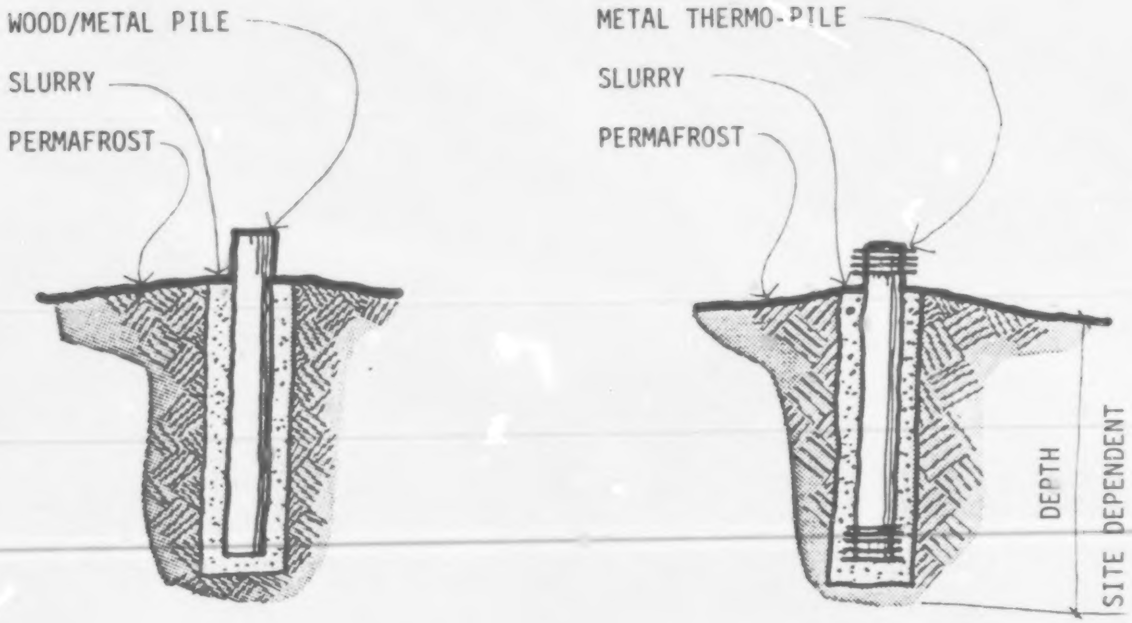
   a. Pile must be kept frozen to retain support.

   b. Special labor and equipment requirements for installation.

STEEL PIPE PILE/THERMAL PILE:

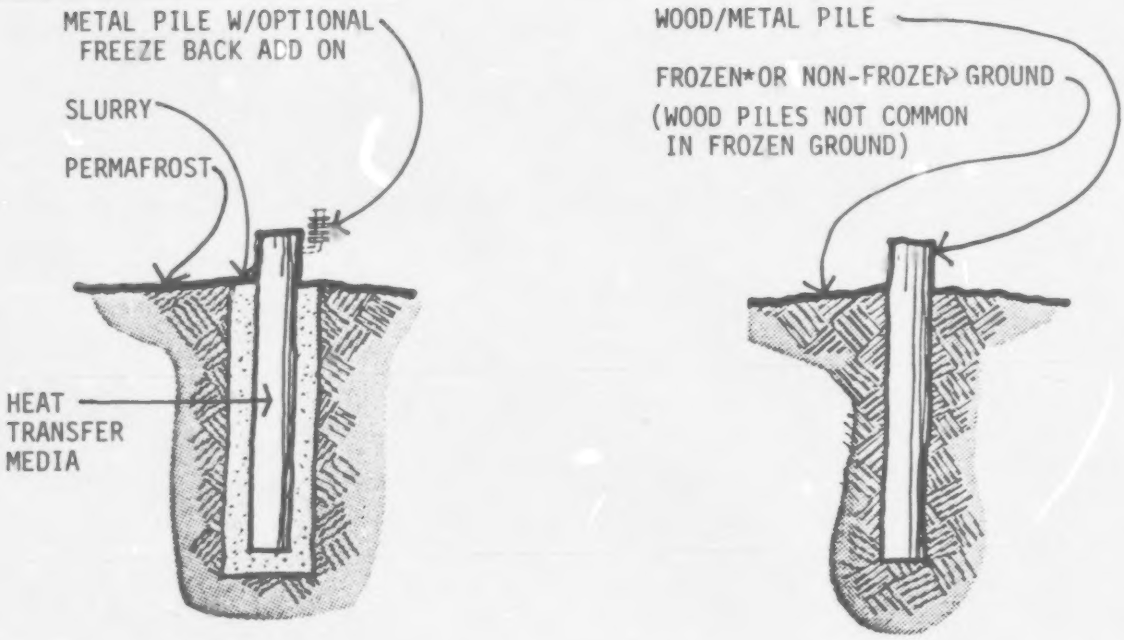
1. Advantages:

   a. Simplicity of installing freeze-back system during or after construction.


WOOD/METAL PILE
SLURRY
PERMAFROST
METAL THERMO-PILE
SLURRY
PERMAFROST
DEPTH
SITE DEPENDENT

A. AUGERED PASSIVE FREEZE BACK

B. AUGERED ACTIVE FREEZE BACK


METAL PILE W/OPTIONAL FREEZE BACK ADD ON
SLURRY
PERMAFROST
HEAT TRANSFER MEDIA
WOOD/METAL PILE
FROZEN*OR NON-FROZEN GROUND
(WOOD PILES NOT COMMON IN FROZEN GROUND)

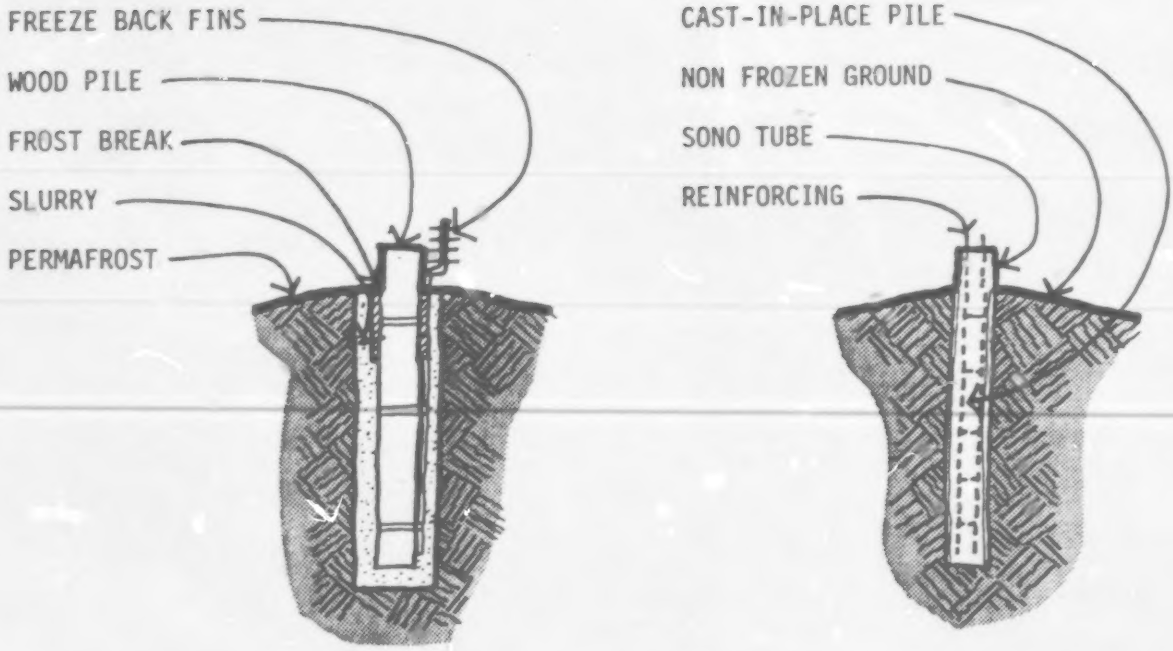
C. AUGERED ACTIVE FREEZE BACK OPTION

D. DRIVEN PILING

*WOOD PILING NOT OFTEN DRIVEN IN PERMAFROST. METAL PILING MAY REQUIRE SPECIAL DESIGN.

PILINGS

FIGURE 8.5


FREEZE BACK FINS
WOOD PILE
FROST BREAK
SLURRY
PERMAFROST
CAST-IN-PLACE PILE
NON FROZEN GROUND
SONO TUBE
REINFORCING

A. AUGERED ACTIVE WITH FREEZE BACK OPTION

B. CAST-IN-PLACE PILE

FIGURE 8.6

b. Active freeze-back system allows relatively short piling to achieve loading requirements.

2. Disadvantages:

a. Soil must remain frozen to support piling.

b. Special labor and equipment requirement for installation.

c. Initial cost will exceed other systems; shorter piling requirements may offset costs, however.

8.223 Hollow Stem Auger Cast-In-Place Pile: This technique requires a hollow stem auger drill to form a cavity in the soil which is filled with P.C.C. as the drill is withdrawn from the soil. In that manner, the hole is fully filled with concrete. Reinforcing steel is added by inserting a "cage" into the P.C.C. The system is applicable to thawed soils and has been used in deep peat deposits. It is generally more economical than driven piling for small projects of less than 200 to 300 piles. (See Figure 8.6B.).

1. Advantages:

a. Can be used in any soil formation.

2. Disadvantages:

a. Can be used in thawed soils only.

b. Requires a large drill rig to handle full pipe length (drill steel) in one piece, concrete pump, mixer, sand-rich aggregate, and suitable water source.

8.23 Pier Foundations:

1. Applicability:

a. End bearing piers are similar in concept to isolated spread footings and are useful where a soft, though free-standing, soil overlies a strong material. In that case, the hole can be placed with a backhoe or drill. In some soils, such as clays and clay-silts, a bell-bottom excavation can be made.

2. Advantages:

a. Simple Post and Pad Techniques:

1) Pad: Concrete, treated timber, or structural fill.
2) Post: Concrete, steel, treated wood, or cast-in-place concrete.

b. In thawed soils, piers can support loads without frost heave if protected with insulation, and heat from the structure is allowed to penetrate around the pile.

c. In frozen soils, piers can support loads without frost heave if frozen material is prevented from thawing.

3. Disadvantages:

a. In thawed soils, the excavation must be free-standing and above the water table.

b. In frozen soils, should be combined with positive refrigeration and protected against thaw.

8.24 Foundations in Permafrost: It is important when working with permafrost to maintain the frozen state. This can be done by either passive or active systems used to control the thermal regime. The system chosen, or combination of systems, depends on the foundation type and on the type of permafrost (whether it is aggrading, degrading, or discontinuous). (See Figures 8.7, and 8.8).

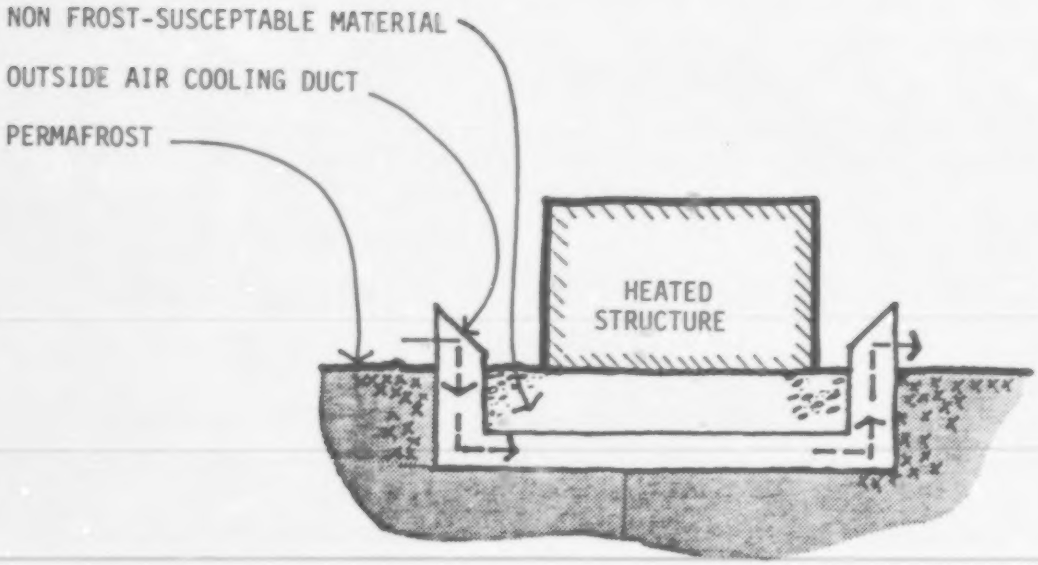
8.241 Passive Systems: This system employs natural cooling; we should evaluate and improve: (See Figure 8.7)

1. Surface Drainage: To carry water sufficiently away from structure (hard to do in low-lying flat delta areas).

2. Reflection of Sun: Use light-colored building pads and surfaces; paint tops of piles and piers with light colored manufactured reflective coatings (not aluminum paint as it absorbs infra-red rays and will cause surface temperature to rise).

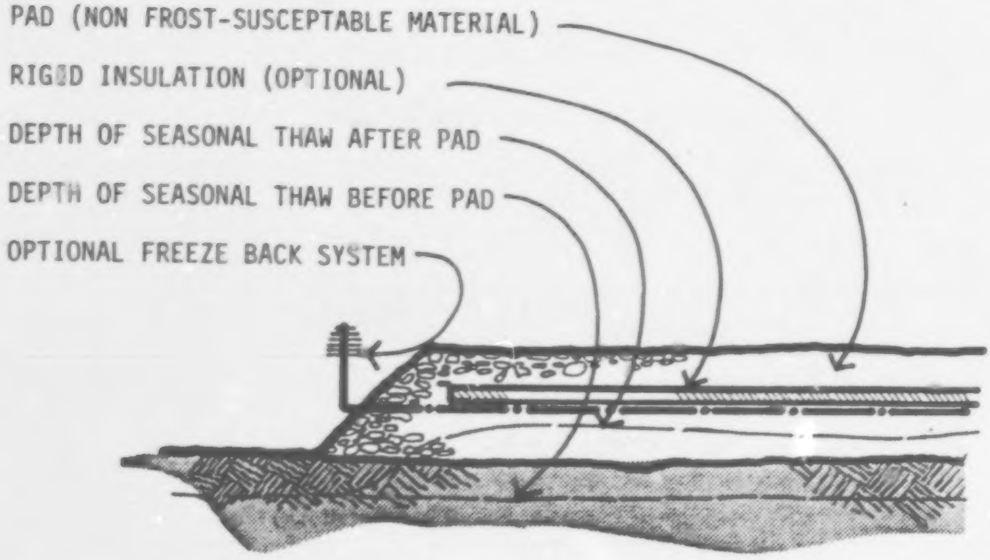
3. Shading and Ventilating the Foundation: A breezeway with three or more feet of clear space, with the beams aligned with the prevailing winter wind, is a common and effective means of maintaining permafrost. Air passages in earth mounds are sometimes used to chill the mounds. The mound allows conventional shallow spread footing construction. A "damper system" is sometimes employed to allow air flow during freezing weather and to block air flow when the air temperature exceeds 32 degrees F. The air is often drawn through the passages by natural draft methods or can be forced with wind or electrically exhausted as in an active system.

4. Insulation: Insulation (natural - vegetation, or manufactured) can be used to reduce affects of heat gain in areas of high heat transfer. Care should be taken to insure that the insulation does not inversely affect winter heat loss in the foundation soil.


NON FROST-SUSCEPTABLE MATERIAL
OUTSIDE AIR COOLING DUCT
PERMAFROST
HEATED STRUCTURE

FOUNDATION W/ PASSIVE COOLING

FIGURE 8.7


PAD (NON FROST-SUSCEPTABLE MATERIAL)
RIGID INSULATION (OPTIONAL)
DEPTH OF SEASONAL THAW AFTER PAD
DEPTH OF SEASONAL THAW BEFORE PAD
OPTIONAL FREEZE BACK SYSTEM

PAD FOUNDATION

FIGURE 8.8

Insulation is most often used to cause the seasonal thaw to remain above a vulnerable layer, i.e., the natural organic mat, an ice layer, etc. Elevated mounds of gravel (isolating building heat from ground), in conjunction with breezeways, tend to raise the seasonal frost line in drained, frost-stable soils. (See Figure 8.8).

5. Deep foundation Systems: Pilings or piers set well into the permafrost allow sufficient depth to avoid failure due to surface thawing. A pile system in poor soils and marginal permafrost areas may require piling 30 feet deep. It is necessary to insure adequate freeze-back prior to loading piling. It may be necessary to incorporate active refrigeration to accelerate and/or guarantee the freeze-back.

8.242 Active System: Refrigeration systems can be used to initially freeze-back soil around deep piles, and annually, or as needed, to maintain a frozen state around all foundation types. (See Figure 8.8).

a. Two-way systems can be used with pads as a horizontal chiller, or vertically with piling. They usually consist of a freezing unit, a heat transfer system pump, plumbing, and a heat transfer fluid (antifreeze, brine, petroleum, etc.). The simplest system uses the winter wind as a freezing unit, a duct system for collection and distribution, and air for the heat exchange fluid. This would amount to a passive system except that the duct must be covered in summer; provisions should be made to exclude moisture (snow, rain, and runoff). More sophisticated systems with temperature-sensitive controls are possible, with the drawbacks of higher complexity, energy requirements, and long-term maintenance. Insulation is important to the two-way refrigeration system's efficiency and should be used to reduce heat gain into the soil. Two-way systems may be used with earthwork pads and conventional shallow spread footings, piers, and piles.

b. One-way systems or thermovalves (Long Thermopile, McDonnell-Douglas Cryo-Anchors) are one-way heat valves which allow heat to flow from the soil to the atmosphere. They are active whenever the air temperature (fin temperature) falls below the soil temperature. Advantages of one-way systems include: they are maintenance free; they tend to depress the ground temperature causing the permafrost to aggrade; and they require a lesser depth of penetration than deep passive methods to develop bearing and resistance to surface thawing.

At the present time, manufacturing of units requires little or no lead time. We expect these systems to be the common foundation-cooling systems for most important remote site installations, as both economic and technical factors indicate they will provide the best long-term performance. Thermopiles are applicable to pile and pier foundations.

8.243 Aggrading Permafrost: This occurs where the heat balance favors freezing ground temperatures, generally below 31 degrees F., with respect to the practical consequences of aggrading permafrost. It is probable that for a specific site, the long-term state will be known only in a general manner and will probably be suspect of degrading; steps should be taken on this assumption. While passive systems work well with a known aggrading situation, active systems are more assured of success in (assumed) degrading conditions.

8.244 Degrading Permafrost: This occurs where the soil temperature is at or above 31 degrees F. Degrading permafrost is probably the most common situation in developing areas due to heat gain from structures, ice fog, loss of natural insulation, increased ground water intrusion, and other environmental changes. In addition, most villages are on the coast or along major rivers, both of which tend to introduce heat into the soil. These systems require evaluation of relocation possibilities and, barring that, emphasis on active foundation-cooling systems.

8.245 Discontinuous Permafrost: The most common and troublesome permafrost configuration is the sporadic occurrence of permafrost. This situation is common throughout the study area in river valleys and plains, and beach and lake fronts; such areas are termed discontinuous permafrost areas. Most villages are in discontinuous permafrost areas; thus, we may expect the occurrence of sporadic permafrost to be a common hazard, as well as degrading (receding) permafrost at most sites. High salt content in groundwater may cause degrading permafrost even in aggrading permafrost zones.

An ice-rich silt with sand, gravel, and organic layers is the most common soil in discontinuous permafrost areas. If the soil is thaw-unstable, we may expect subsidence, compression, and consolidation of the thawed permafrost soil under the foundation loads. These several actions will occur at differing time rates and will result in unequal volume changes in the soil; causing continuing differential movement. If ice-rich soils are involved, the differential movement can be on the order of several feet.

A common error where evaluating a site for foundation conditions is to assume that settlement (due to these causes) is not a factor as existing small buildings may appear stable. The scale effect of building size allows a much greater chance of founding the structure part in and part out of the permafrost, and also serves to magnify differential movement. The magnitude of this hazard is such that detailed borings capable of detecting thawed and frozen soils, ice-rich materials, thaw stable, and thaw unstable soils (within the influence of the foundation system on a 50-foot grid) is desirable. Unfortunately, costs, custom, and schedules seldom allow exploration which satisfactorily evaluates the hazard in sufficient detail to utilize composite foundation systems. Therefore, it is often prudent to treat the building site as a degrading permafrost and to provide freeze-back systems, or, if subsurface conditions permit, to design a bearing pile system assuming no benefit from adfreeze strengths. Frost heave about the freeze-back pile is possible; therefore, the use of adjustable pile-superstructure connections is a necessary precaution.

If it can be demonstrated that the site is fully frozen or thawed, one may proceed with greater confidence with the appropriate foundation systems as described elsewhere in this study. Care should be taken, when siting the structure in an area of sporadically thawed and frozen soils, to provide a tight exploration pattern on the order of 50 foot centers to depths of 35 feet or more.

8.25 Foundation Systems Summary: The dangers involved in founding structures in the sub-arctic and arctic are largely related to volume change in the foundation material by freezing and/or thawing. Thawing during construction can cause extreme construction difficulties and errors, with consequent deleterious affects on the structure's short and long-term performance.

The principal construction difficulty is a result of surface and subsurface water intrusion into the foundation excavation, followed by destruction of natural ground insulation in permafrost or frozen seasonal frost areas. The problem is manifested by wet caving excavations. The cures are related to ground temperature and drainage. Cold ground temperature and avoidance of free water allow construction to progress.

Use of wooden piling (placed in predrilled holes and backfilled with slurry) is the most common technique used for founding structures on permafrost. The use of driven piling is presently being considered favorably, provided extremely strong piles and drivers are used in permafrost. However, the several possible foundation systems should be evaluated for cost and efficient application to the specific site.

Existing transportation and communication patterns place most villages near streams and water bodies, with the result that the majority of foundation soils are alluvial, often organic, and generally subject to discontinuous fragile permafrost. In a few cases, the materials are clearly favorable (being thawed gravels or rock).

Exploration for foundation should take into account the structure's tolerance to differential movement and its importance. The exploration should be sufficient to select the system and to avoid subsurface hazards. To accomplish these self-evident goals is often impractical, due to scheduling of the project, available transportation, as well as often being overly costly with relationship to the design choices.

8.3 BUILDING ENVELOPE EXTERIOR ELEMENTS: The performance of the exterior envelope with regard to weather, thermal, and vapor characteristics becomes very critical in this environment (northern) as compared to more temperate regions. The exterior skin must respond to long periods of dry, cold air, and/or constant wind-borne precipitation (snow and rain) where remote sites mean poor maintenance and a need for simply erected and transportable materials. Insulation must be of high thermal resistance and easily installed in remote sites; and either unaffected by moisture (integral vapor barrier), or provisions made to allow it to dry within the wall, roof, or floor cavities. Warm air should circulate over the interior surface of the envelope so surfaces do not cool to below freezing. This causes interior icing and items may freeze to the wall. Adequate thermal breaks between interior and exterior surfaces must be considered; this is especially important wherever penetrations occur, such as at vents, window and door frames, fasteners, mechanical penetrations, etc.

The exterior building envelope is typically made up of the following elements, each of which performs a distinct environmental or structural function. These elements are often combined in one material to solve several functional requirements simultaneously. (See Section 8.4).

8.31 Exterior Skin: The exterior skin consists of a barrier designed to prevent precipitation, sunlight, and soil from entering the building. It may also serve as a fire-resistant barrier. The skin must be designed to allow moisture laden air that has leaked from the building's interior to escape to the outside and not become entrapped within the insulated cavity. The designer must consider materials that are not affected by icing that forms from vapor escaping from windows and mechanical penetrations.

8.32 Structural Skin: The structural skin may be integral with the exterior skin, or separate, providing a surface to distribute dead, live, wind, and seismic loads, as well as a surface for anchoring the exterior skin. A structural layer, typically plywood, will be required wherever stresses and loads cannot be carried by the interior or the exterior finish.

8.33 Insulation Layer:

1. Fiberglass batt insulation has the following advantages: good stability if it should become temporarily moist (although flooding will eventually cause it to mat down); simple installation; is relatively noncombustible; and is easily shipped. Care must be taken to install batts so that there are no voids around structural members or other building components. This can be solved by using a combination of batts and blown-in insulation on top to seal voids. Mechanical barriers (insulation hold-down) must keep vents unobstructed.

2. Blown-in insulation is generally used as an alternative to batt insulation where pneumatic installation of insulation is the only practical method available. Blown-in insulation is designed for use with standard automatic and hand-fed mineral fiber blowing wool machines. The R-value varies and is dependent upon type and application of the material to the thickness and density recommended by the manufacturer. Like fiberglass batt, most blown-in insulation is easily compacted and light-weight for shipping.

3. Foam plastic insulation comes in two general forms; preformed rigid pieces, and foamed-in-place. Both forms are less moisture susceptible than fiberglass batt insulation. This feature makes foam plastic insulation more desirable in areas potentially subject to moisture, i.e., utilidors, underfloor cavity below water and glycol heat lines, etc. The structural characteristics of this insulation permit it to be used in structural panels, as direct underlayment or backing, and as its own form. Foamed-in-place insulation can be used as a sealant when sprayed onto the building envelope. Fire-barrier coatings are often needed on foam-plastic insulation for building code compliance. Preformed rigid pieces are light and bulky for shipment. Foamed-in-place insulation requires equipment and skilled labor for application.

8.34 Vapor Barrier: Vapor barriers are placed on the heated side of insulation to inhibit migration of moist interior air to the insulation. Specifications must indicate the importance of careful installation of the vapor barrier. All edges must be carefully lapped and sealed according to specific manufacturer's recommendations. Penetrations through vapor barriers must be kept to a minimum and be well sealed. Electrical conduit and receptacles, for example, must not penetrate the vapor barrier. They can be mounted exposed on the finished wall or ceiling surface (which facilitates easy modifications), or may be mounted in a furred space between the interior skin and vapor barrier. Placement of the vapor barrier must consider potential damage during construction. When feasible, place the vapor barrier directly on durable material (plywood substrate, etc.) to reduce potential damage during construction. Vapor barrier materials for consideration are: polyethelene, mylar-faced aluminum, polyvinyl chloride, etc.

8.4 BUILDING ENVELOPE EXTERIOR SYSTEMS: Elements of the exterior building envelope discussed in Section 8.3 are combined to create an exterior envelope system. Typically, due to different structural and environmental requirements, there is a distinct envelope system for each of the three major exterior building envelope components: 1) floors; 2) walls; and 3) roofs.

8.41 Floor Forms: The three basic floor types are described below. (See Figure 8.9).

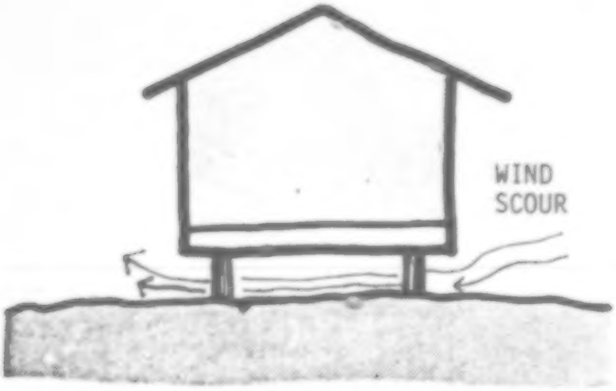
8.411 Enclosed Crawl Space: Various floor systems over an enclosed crawl space (crawl space may be heated).

1. Use:
    a. Used where soil and climatic conditions allow perimeter footing construction.
    b. The crawl space enclosure system can be of preservative treated wood.
2. Advantages:
    a. Provides heated space for mechanical systems, and a comfortable and accessible environment for servicing this equipment.
    b. Good future growth and flexibility potential for mechanical and electrical systems.
    c. Conventional framing of preservative treated wood foundation walls (where applicable) in the field.
3. Disadvantages:
    a. Limited to certain soil and climatic regions.
    b. Not recommended for areas with a high water table, flooding potential, and severe snowdrifting.

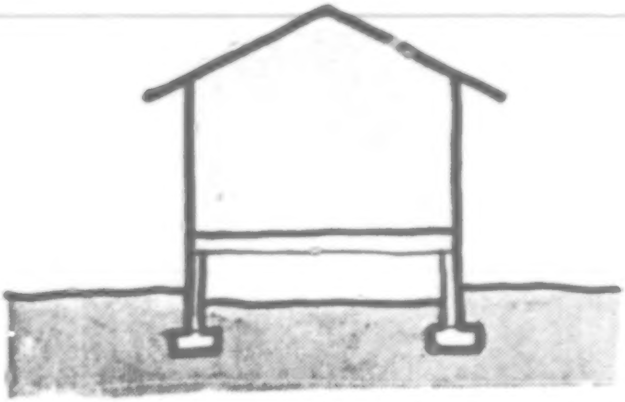
8.412 Raised Floor: Environmental determinants such as permafrost, severe snowdrifting, groundwater, or flooding will affect the selection of a floor system and the method of assembly.

1. Use: When utilizing a site with any of the above conditions, the building will be thermally isolated from the ground by posts, piers, piles, or other suitable means. (See Figure 8.9). Placement of the vapor barrier should consider damage to same during construction. When possible, place the vapor barrier directly on durable sheet material (between underlayment and subfloor) to reduce potential damage during construction.

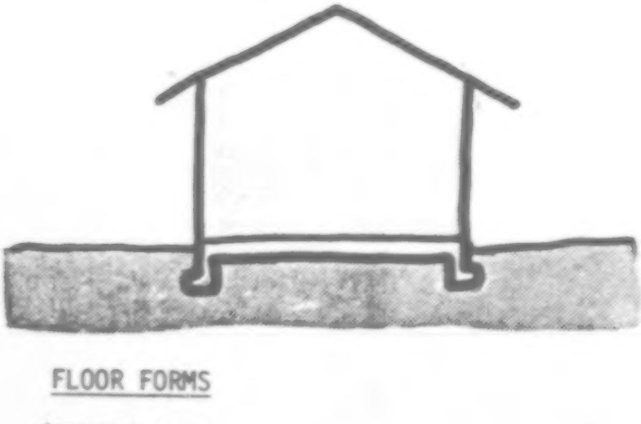
RAISED FLOOR:
ON PIER OR PILINGS WITH HEATED UNDER FLOOR SPACE. RAISED FLOOR PROTECTS PERMAFROST FROM BUILDING HEAT AND ALLOWS WINTER WINDS TO SCOUR UNDERNEATH BUILDING.



ENCLOSED CRAWL SPACE:
PERIMETER FOOTINGS AND STEM WALLS OF PRESERVATIVE TREATED WOOD, CONCRETE OR MASONRY BLOCK. CRAWL SPACE MAY BE HEATED DEPENDING ON SOIL CONDITIONS.



SLAB ON GRADE:
CONCRETE SLAB CAN BE USED ON WELL DRAINED NON-FROST SUSCEPTIBLE SOILS. FLOOR SLAB SHOULD BE WELL INSULATED IF SPACE ABOVE IS TO BE OCCUPIED.



FLOOR FORMS

(FIGURE 8.9)

2. Advantages:

a. Reduces risk by building heat loss of thawing permafrost.

b. Winter winds can scour under the building (barring major obstructions such as skirting or snowdrifts) cooling the ground, thus aiding in keeping it frozen and stable.

c. Minimizes drift problems on lee side of building.

d. Elevated floor systems will have limited problems with wet ground conditions or flooding which can protect insulation and equipment within the floor system from moisture damage.

3. Disadvantages:

a. Raising the building off the ground without perimeter skirting increases the need for floor insulation and a proper heating system to prevent cold floors and problems with any subfloor mechanical systems.

b. Skirted buildings in high water areas will need provisions for drainage and ventilation.

8.413 Slab-on-Grade On-grade: Can be utilized where soils are well-drained and not susceptible to frost heaves. When proper soil conditions are present, the building may be constructed on a concrete slab pour, directly onto the prepared grade. Slab will need to be carefully insulated if building is to be occupied. For Advantages and Disadvantages, see Section 8.215.

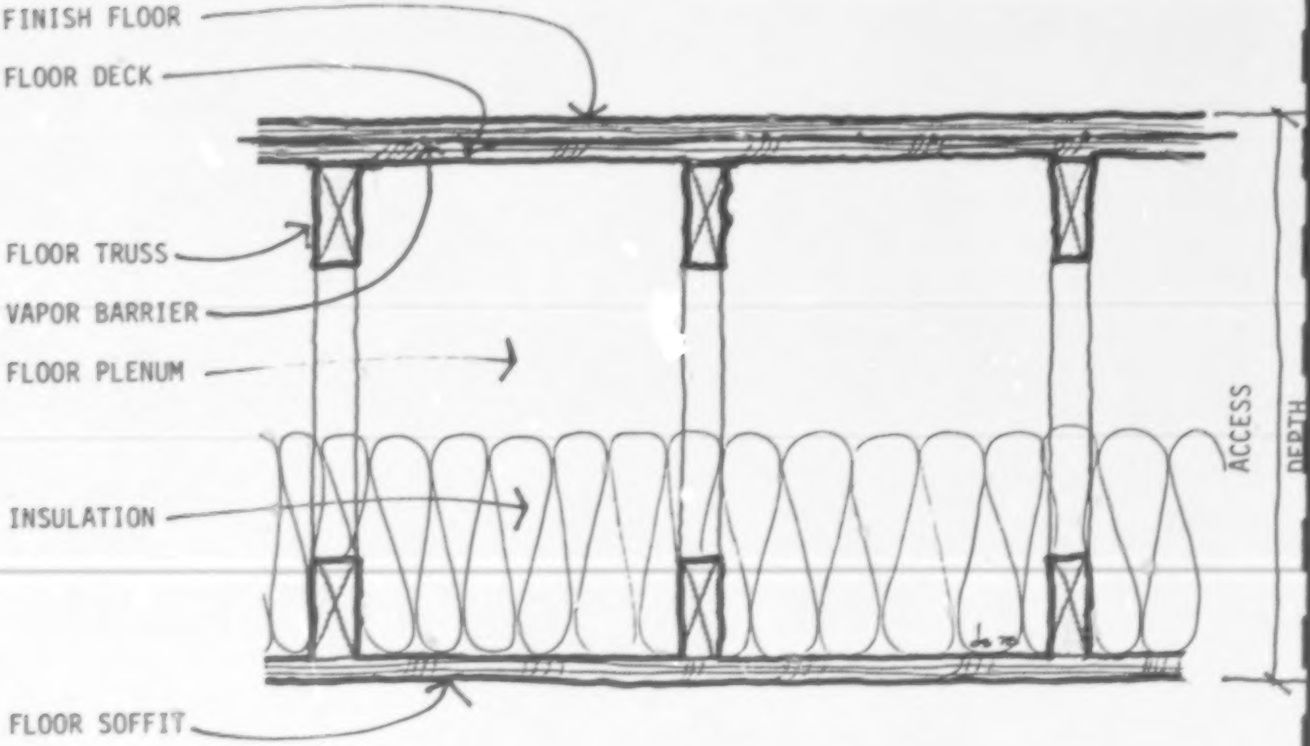
8.42 Floor Systems: Common floor systems that may be applied to above-floor forms are discussed below:

8.421 Truss Floor System: Floor Systems #1 and #2 incorporate open trusses allowing for space below the floor to be heated, thus resisting cold floors. This space can also be utilized for distributing utilities. Placement of the vapor barrier should consider damage to same during construction. (See Figures 8.10, and 8.11).

1. Use:

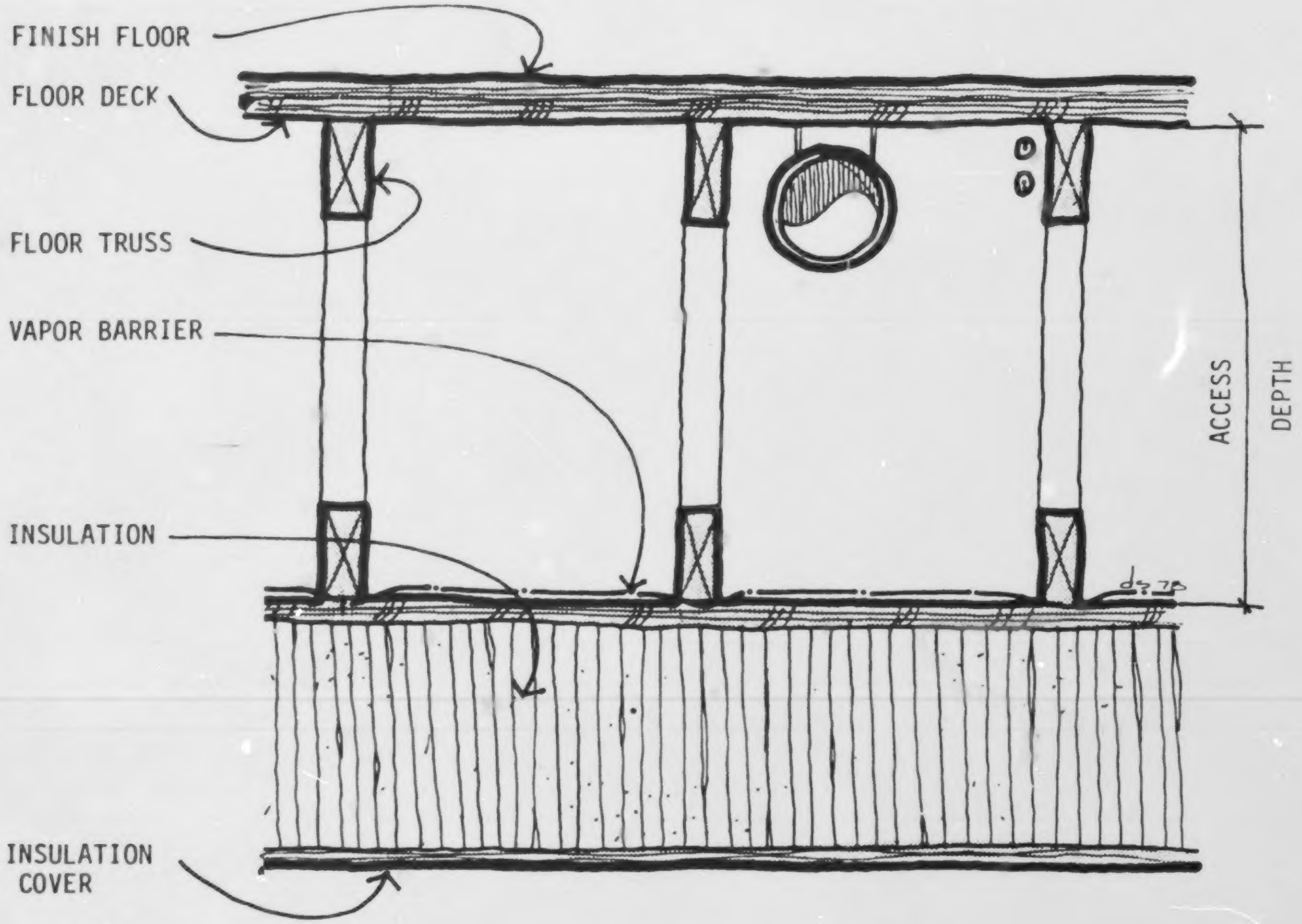
a. Can be used for long spans, thus reducing foundation support systems where bearing pressures permit.

b. Provides the opportunity for actively heating floor space.


FINISH FLOOR
FLOOR DECK
FLOOR TRUSS
VAPOR BARRIER
FLOOR PLENUM
INSULATION
FLOOR SOFFIT
ACCESS
DEPTH

FLOOR SYSTEM 1

FIGURE 8.10


FINISH FLOOR
FLOOR DECK
FLOOR TRUSS
VAPOR BARRIER
INSULATION
INSULATION COVER
ACCESS DEPTH

FLOOR SYSTEM 2

FIGURE 8.11

c. Insulation can be installed below the floor system; thereby, the occurrence of insulation voids (Floor System #2).

d. In Floor System #1, insulation can be placed between the trusses, and voids can be reduced by adding a layer of blown-in insulation. (R-value for blown-in insulation to be specified by designer).

2. Advantages:

a. Space may provide a heated subfloor area to reduce cold floors and make utility distribution more flexible. Future utility distribution potential is enhanced.

b. Design can allow for subfloor mechanical and electrical distribution to be accessible from inside the building, thereby providing a comfortable working environment, as well as preventing cold air from entering the space while doing repairs. Vapor barrier penetration at access opening to be detailed.

c. Trusses can be either field-assembled or preassembled depending on transportation and other criteria.

3. Disadvantages:

a. Floor system can be bouncy if trusses are designed too close to their critical deflection. Also, spaces around multipurpose rooms can receive structure-borne impact noises from activities within that space. The floor system must be designed to account for acoustic transfer.

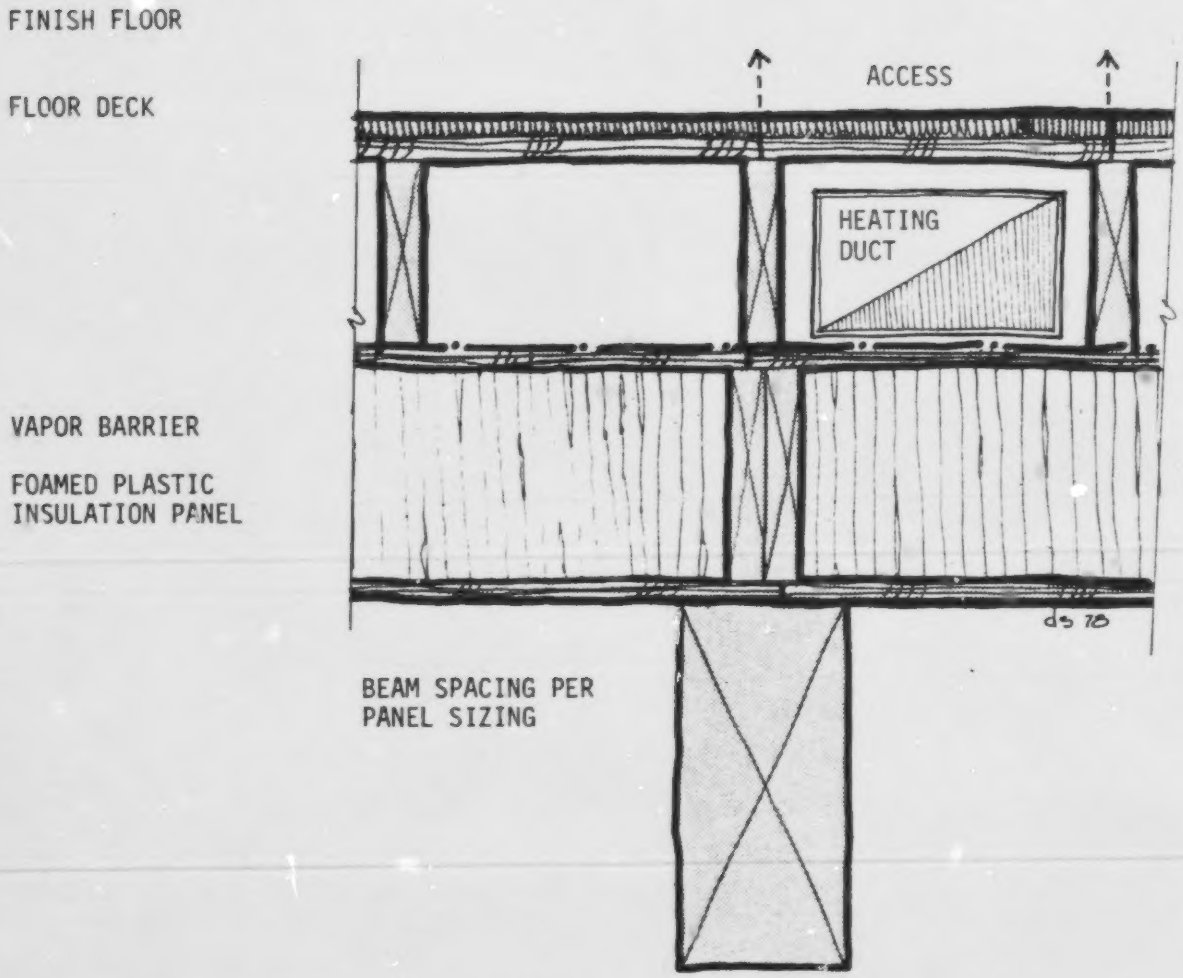
b. Floors can sound hollow if decking and floor finishes are not carefully selected.

c. Sprinklering of deep subfloor spaces may be considered for insurance savings when applicable.

d. Subfloor system increases the total volume of space requiring heating, as well as protection from weather.

8.422 Stress Skin Panel Floor System: Floor System #3 incorporates stress skin panels, with integral foam-plastic insulation supporting plywood floor decking on 2 x 6 sleepers (typically prefabricated). (See Figures 8.12, and 8.13).

1. Use: Can be used to clear floor spans between girder and substructure supports.

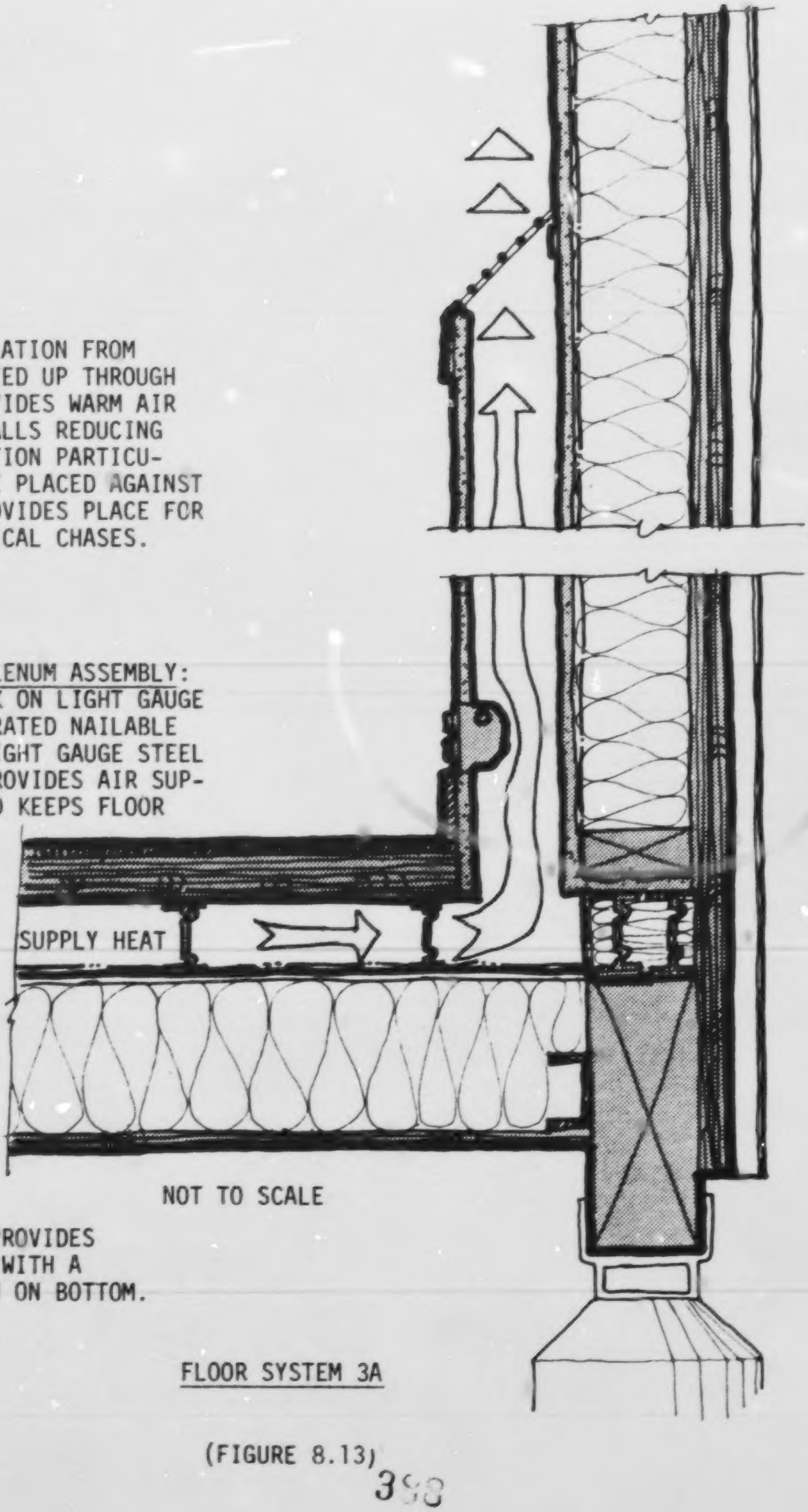

FINISH FLOOR
FLOOR DECK
ACCESS
HEATING DUCT
VAPOR BARRIER
FOAMED PLASTIC INSULATION PANEL
ds 78
BEAM SPACING PER PANEL SIZING

FLOOR SYSTEM 3

FIGURE 8.12

WALL PLENUM:
SUPPLY HEAT AND VENTILATION FROM FLOOR PLENUM IS DIRECTED UP THROUGH WALL PLENUM. THIS PROVIDES WARM AIR WASHING OF EXTERIOR WALLS REDUCING COLD SPOTS & CONDENSATION PARTICULARLY BEHIND FURNITURE PLACED AGAINST WALLS. WALL PLENUM PROVIDES PLACE FOR MECHANICAL AND ELECTRICAL CHASES.

PREFABRICATED FLOOR PLENUM ASSEMBLY:
FIRE TREATED WOOD DECK ON LIGHT GAUGE STEEL SKIN WITH PERFORATED NAILABLE STEEL JOISTS WITH A LIGHT GAUGE STEEL BOTTOM SKIN. PLENUM PROVIDES AIR SUPPLY TO WALL PLENUM AND KEEPS FLOOR WARM.



SOFFIT ASSEMBLY:
STRUCTURAL ASSEMBLY PROVIDES SPACE FOR INSULATION WITH A PLYWOOD OR METAL SKIN ON BOTTOM.

FLOOR SYSTEM 3A

(FIGURE 8.13)

2. Advantages:

   a. A prefabricated system can be rapidly assembled without the use of sophisticated or time-consuming field assembly techniques. This aids in quick enclosure of the building during a short construction season.

   b. Space created by sleepers and a plywood floor deck allows mechanical and electrical distribution. (See Section 5.49).

   c. Accessibility to equipment and distribution systems in this space is possible without jeopardizing structural integrity of the floor system. Cutting and patching of the deck or sleepers for emergency access or future flexibility is not a major structural concern. However, readily accessible mechanical equipment will more likely be maintained.

   d. Sleeper space could be heated to provide a warm floor surface for occupants.

   e. For sprinkler requirement considerations regarding this space, see Section 5.25.

2. Disadvantages:

   a. Panels will probably be preassembled due to critical quality control requirements, adding consideration for local labor and shipping constraints.

   b. Panels are relatively bulky to ship.

   c. Consideration of code requirements will be required for foam-plastic insulation panel assemblies.

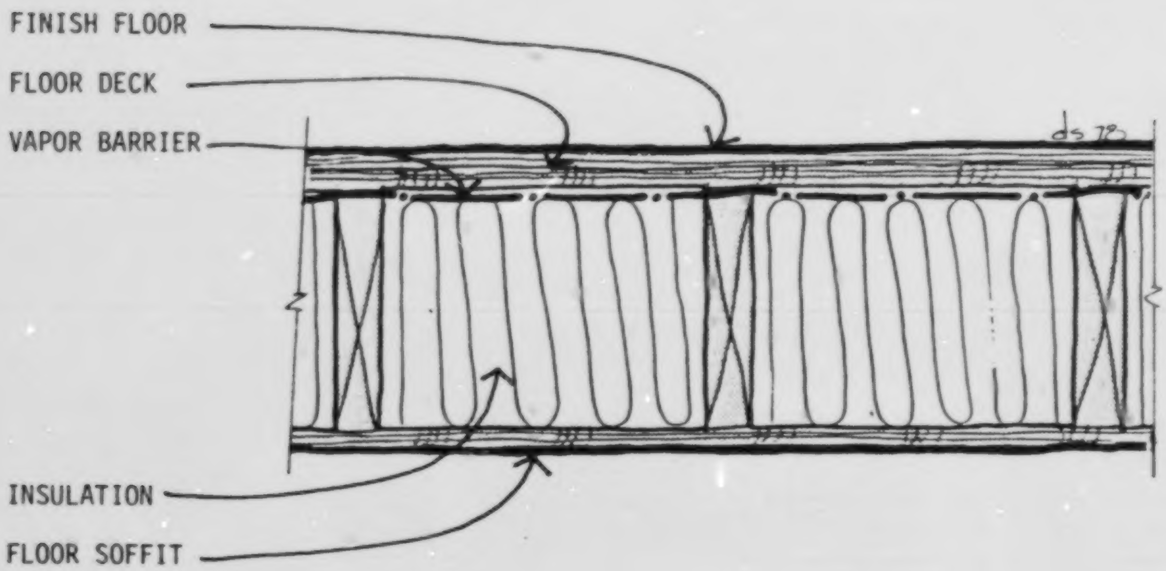
8.423 Conventional Floor Joist Construction: Wood joists on beams or girder. Floor System #4 placement of vapor barrier should consider damage during construction. (See Figure 8.14).

1. Use: Recommended for unoccupied spaces (cold storage, generator buildings, etc.), or when warm floor is not feasible.

2. Advantages:

   a. Easy to field-assemble with high, local labor potential.

   b. Pieces can be easily transported to site.


FINISH FLOOR
FLOOR DECK
VAPOR BARRIER
INSULATION
FLOOR SOFFIT
ds 78

FLOOR SYSTEM 4

FIGURE 8.14

3. Disadvantages:

   a. It is difficult to introduce heat internally to combat cold floors.

   b. Mechanical and electrical equipment or distribution systems located below the finished floor are prone to freezing since it is not a heated space. Accessibility and clearances for these systems are a consideration.

   c. Developing a good thermal break between the interior and exterior of the floor system is difficult.

   d. Site labor is intensive.

8.424 Floor Joist Construction Over Enclosed Crawl Space: Floor System #5; 2" x wood joists on treated wood foundation walls. Placement of vapor barrier should consider damage duirng construction. (See Figure 8.15).

8.43 Wall Systems:

8.431 Conventional Wood Stud (or Metal Stud) Wall System: The common stud wall system consists of an exterior wood or metal skin; structural skin; wood or metal studs (spaced at 16" or 24" on center, depending on structural requirements); insulation; vapor barrier; and interior wall. In arctic environments, studs will be typically much deeper than encountered in residential construction found in more temperate areas due to structural (wind, seismic, and roof load) and insulation thickness requirements. (See Figures 8.13, and 8.16).

1. Use: All climatic areas.

2. Advantages:

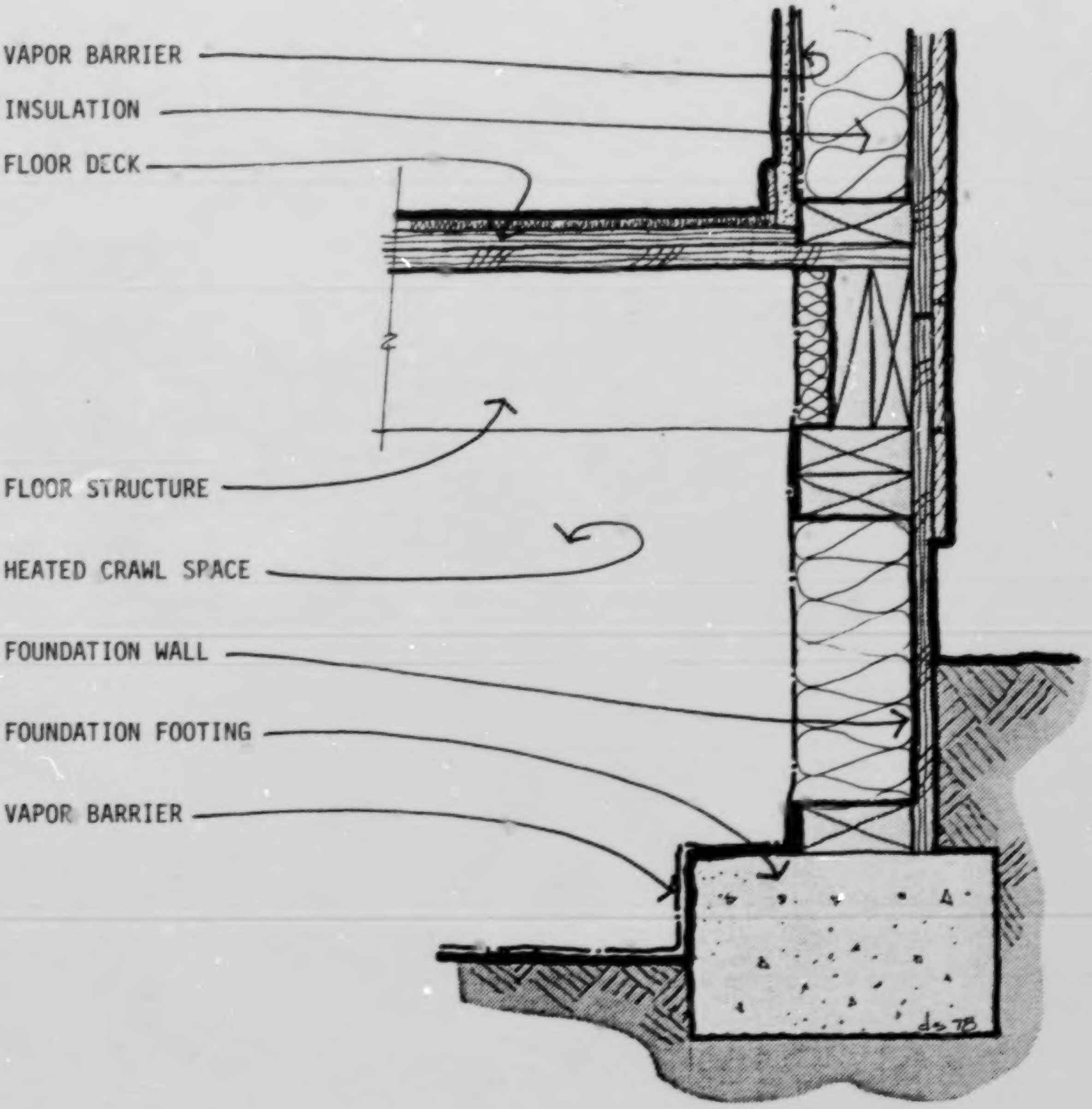
   a. Can be shop fabricated into panels and quickly field-erected, often with semi-skilled labor.

   b. May be field-assembled from pieces, a system which has been widely used. Many people in rural areas have had experience with wood stud construction.

   c. Unassembled pieces can be easily shipped to most site locations.

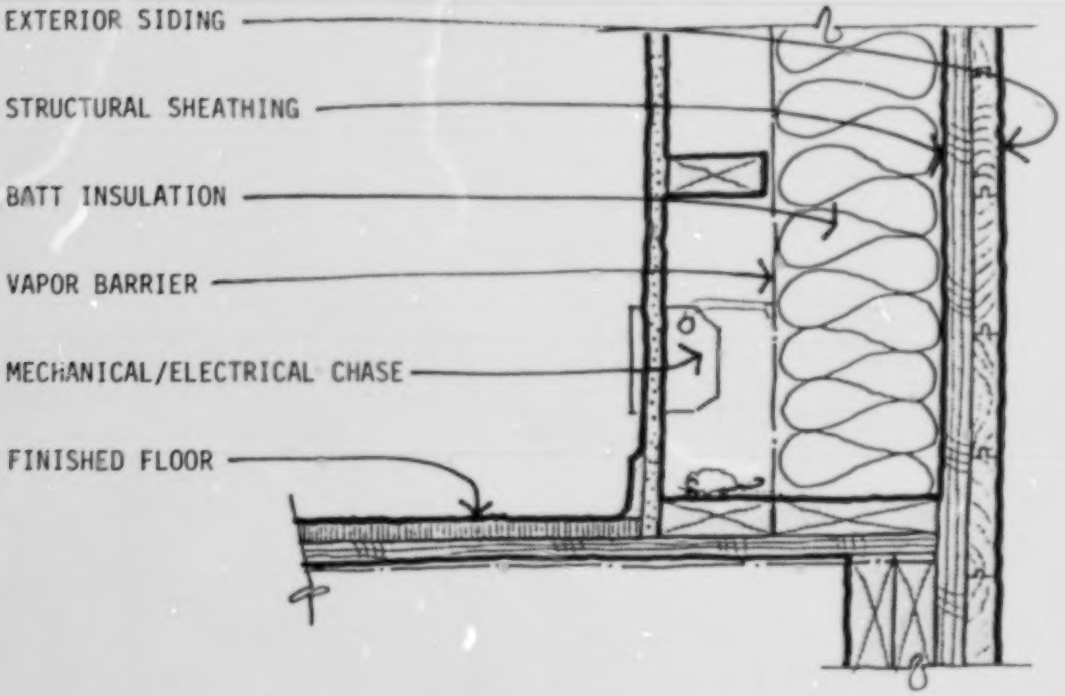
3. Disadvantages:

   a. Shop-assembled panels may be difficult to ship and place at remote construction sites due to limited runways or on-site handling equipment.


VAPOR BARRIER
INSULATION
FLOOR DECK
FLOOR STRUCTURE
HEATED CRAWL SPACE
FOUNDATION WALL
FOUNDATION FOOTING
VAPOR BARRIER
ds 78

FLOOR SYSTEM 5

FIGURE 8.15


EXTERIOR SIDING
STRUCTURAL SHEATHING
BATT INSULATION
VAPOR BARRIER
MECHANICAL/ELECTRICAL CHASE
FINISHED FLOOR

WALL SECTION

FIGURE 8.16

b. May require special exterior and interior finishes to meet special fire protection requirements.

8.432 Sandwich Panel Skin: The exterior wall may consist of a sandwich panel with foam-plastic insulation sandwiched between metal, exterior wood siding, or factory-finished cement asbestos board and an interior finish panel.

1. Use: All climatic areas.

2. Advantages:

   a. Shop-fabricated and quickly field-erected; some systems can be erected in the field without skilled labor.

   b. Potential for achieving high R-value with less thickness than fiberglass batt insulated wall.

   c. Thermal characteristics not as adversely affected by moisture as batt insulation.

3. Disadvantages:

   a. Transportation to remote sites is a consideration due to bulk and size of panel.

   b. Some systems require close tolerance levels in joining panels together.

   c. Metal panel systems may suffer from interior icing unless the thermal barrier is maintained between interior and exterior surfaces.

   d Some stock panel systems may not provide adequate thermal value for climate encountered; custom panel system may be needed.

8.44 Roofs: Roofs have the potential for being one of the most critical problem areas of the building envelope. This study area is critical because climatic conditions include any combination of rain, snow, extreme temperature differentials, sun, and wind.

Pitched roofs offer the most suitable form for small rural facilities. Flat roofs are susceptible to high snow loadings, and difficult to successfully ventilate the insulated cavity (when necessary). The flat roof membrane usually requires application procedures and equipment which are not easily obtained in remote locations. Repair of bituminous or elastomeric membranes is difficult and may require specialized skills and equipment. Pitched roofs allow for a great deal of flexibility to accommodate rain and snow shed, snow loading, and snowdrifting requirements.

8.441 Hot Roof: A hot roof consists of an exterior skin adjacent to the insulated warm space. (See Figure 8.17). In a climate where the wind is found to be constant enough to keep the roof clear of snow, hot roofs may be appropriate.

1. Advantages:

   a. Insulation (rigid type) is usually on top of the structural system. Large voids in the insulation are minimized, creating a more continuous thermal break.

   b. The vapor barrier will most likely be on top of the structural deck in this design. It is less likely to be damaged during or after construction. There is no danger of penetration by ceiling fixtures, pipes, conduits, etc.

   c. The warm roof may create a cavity for placement of uninsulated water pipes.

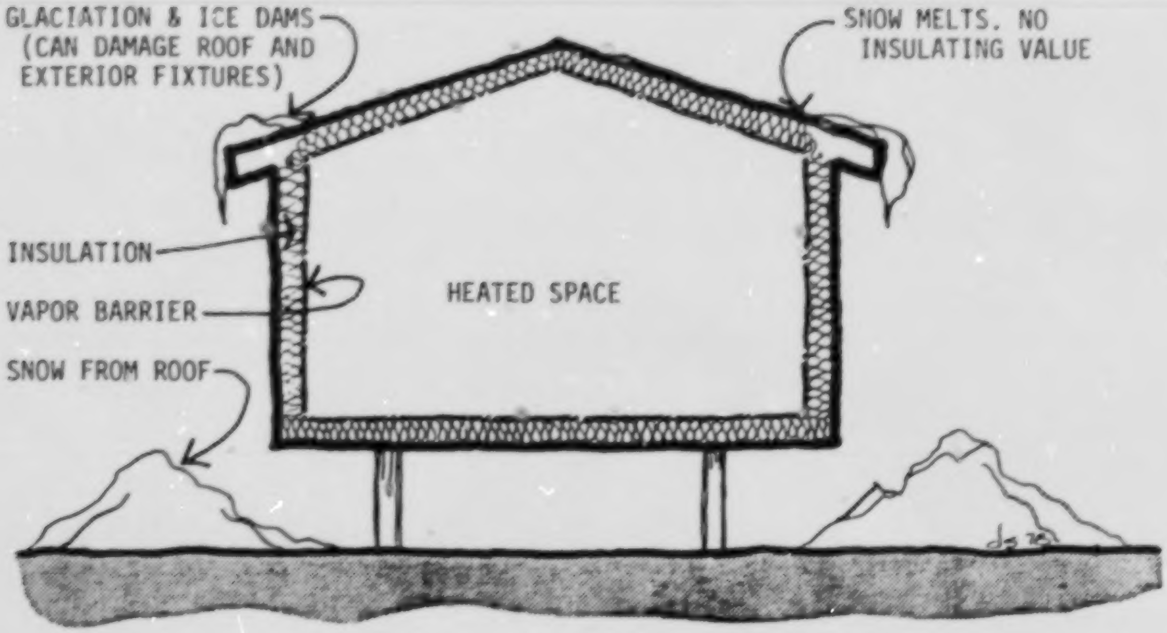
2. Disadvantages:

   a. Heat transfer through this kind of roof assembly will melt snow on the roof which then freezes upon contact with cold eaves, thus causing glaciering. When the glaciered ice falls from the roof eave, it may injure pedestrians and/or damage the eave, exterior wall mounted equipment, doors, and windows.

   b. Adequate fastening of rigid insulation to the roof deck normally requires an undesirable amount of conductive fasteners.

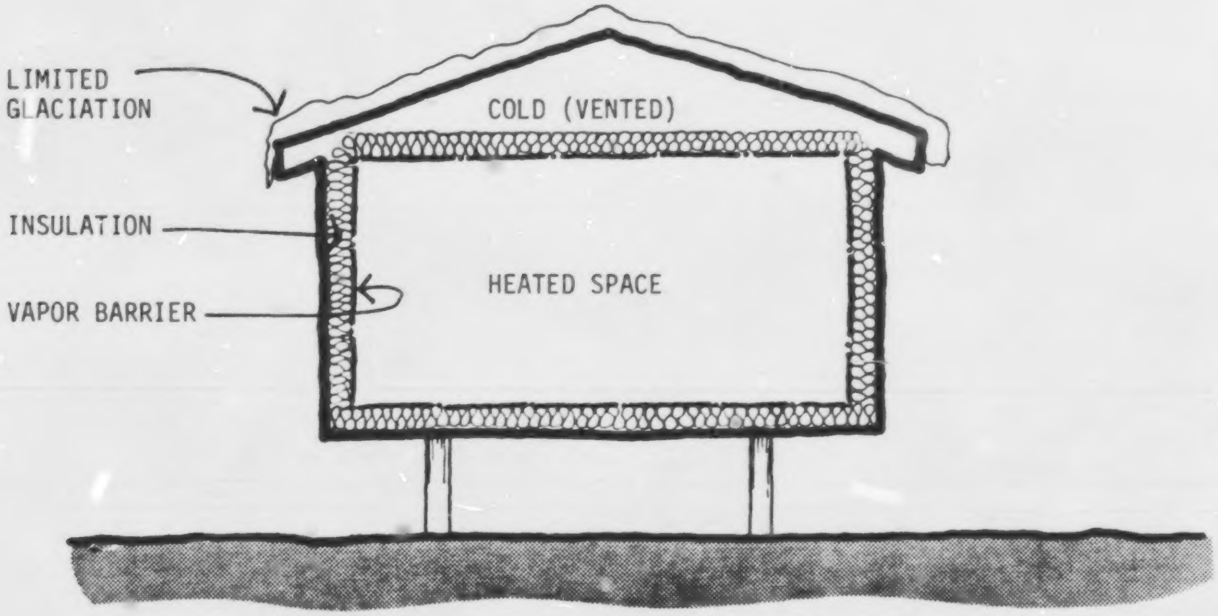
   c. Because of danger to pedestrians, it is recommended that hot roofs not be used in areas where snow accumulates on the roof, and the roof is not constantly blown clear.

8.442 Cold Roof: A cold roof system provides thermal isolation of the roof skin from building heat. Thermal isolation allows snow to melt only when the entire roof surface thaws (including unheated eaves); thus, water runs off the roof surface and minimizes glaciation at unheated eaves. Most often, roof skin thermal isolation is achieved by construction of an air space ventilated (cooled) by outside air. Often, the ventilated air space sees double-duty by promoting vapor escapement from moisture susceptible insulation. The ventilated insulation remains dry and retains desirable thermal qualitites. Location of eave vents with regard to windows and minimum attic ventilation requirements are given in the UBC, Section 3205(c). A cold roof system is recommended for use whenever snow accumulates on roofs and may become hazardous. (See Figures 8.18, and 8.19).


GLACIATION & ICE DAMS (CAN DAMAGE ROOF AND EXTERIOR FIXTURES)
SNOW MELTS, NO INSULATING VALUE
INSULATION
VAPOR BARRIER
HEATED SPACE
SNOW FROM ROOF

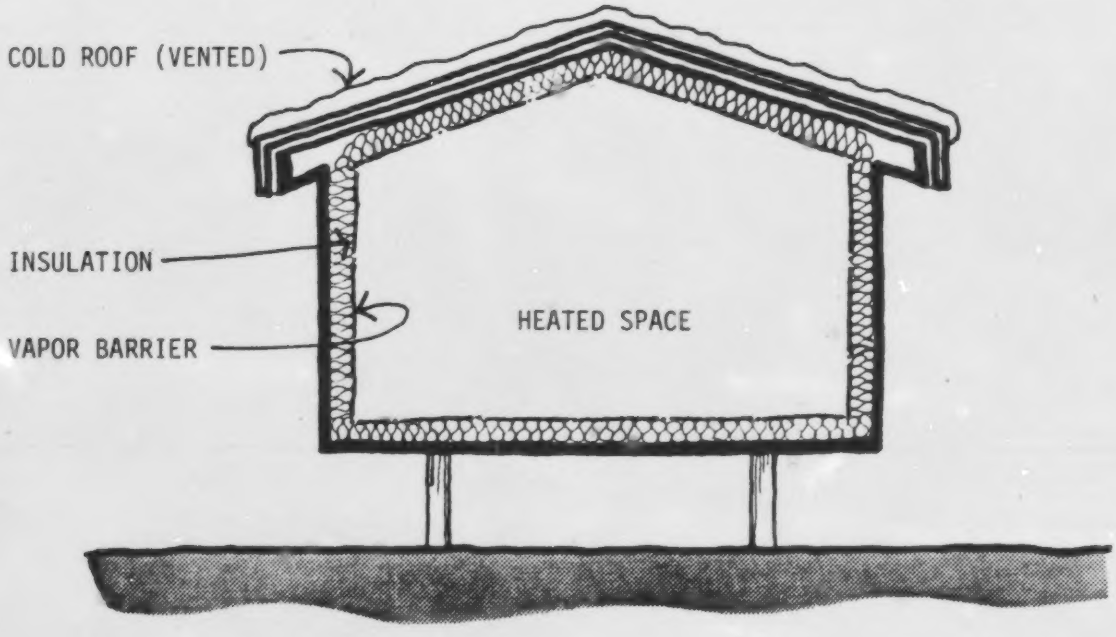
HOT ROOF

FIGURE 8.17


LIMITED GLACIATION
COLD (VENTED)
INSULATION
HEATED SPACE
VAPOR BARRIER

COLD ROOF

FIGURE 8.18


COLD ROOF (VENTED)
INSULATION
HEATED SPACE
VAPOR BARRIER

COLD ROOF

FIGURE 8.19

1. Advantages:

   a. Insulation is kept dry and fully effective.

   b. Glaciation is minimized and the associated hazards are reduced. (See Section 8.441, Disadvantages).

2. Disadvantages:

   a. A poorly designed cold roof may have ice within the roof cavity due to vapor condensing on the inside of the cold roof surface because of restricted ventilation, and/or blowing snow carried into the ventilated cavity. These frozen forms of moisture may eventually melt before sublimation occurs and cause damage to the inside of the building. Trapped warm air can give similar negative symptoms as a hot roof. (See Section 8.431).

8.443 Roof Components: A typical roof consists of five major components: 1) roof membrane (exterior skin); 2) structural roof assembly; 3) ventilated air cavity; 4) insulation; and 5) vapor barrier.

1. Roof Membrane: Designed to protect the rest of the roof components from weather, i.e., rain, snow, sun, and wind. Pitched roof membranes typically consist of:

   a. Formed sheet metal (aluminum or steel) on a weather-resistant felt.

   b. Asbestos or wood shingles on a weather-resistant felt.

   c. Asphalt and composition shingles or rolled roofing.

   d. Sod roofs.

   A typical flat roof membrane is an asphalt or elastomeric mopped membrane (not recommended for steep pitches).

   Advantages:

   PITCHED ROOFS:

   a. Ribbed SHEET metal is a commonly used skin for typical rural applications due to ease of installation, durability, low maintenance, few seams, light-weight, and noncombustible properties.

   b. Composition shingles or rolled roofing and asbestos or wood shingles are readily installed, repaired, and retains snow better than a smooth metal roof, thus reducing hazards from snow slides.

c. These materials can be obtained with fire-retardant treating.

FLAT ROOFS:

a. Asphalt or elastomeric mopped roofs are ideal for flat roofs or areas with minimal pitch and, when properly applied, will not have any exposed seams.

b. Sod roofs provide both aesthetic and insulative values with indigenous materials.

Disadvantages:

PITCHED ROOFS:

a. Care must be taken in design of flashing and fastening details for metal roofs to accommodate local high wind conditions for uplift, blowing rain, and snow. Thermal expansion and contraction of metal can work fasteners out of a wood substructure. Some owners insist that only steel skin roofs be used because of concern that fasteners in an aluminum roof will, over a period of time, enlarge the fastening holes in the membrane and be more prone to wind damage. Care needs to be taken in specifying both the vertical and horizontal joint lapping for metal sheets, and how they are sealed to prevent penetration of moisture due to wind or ice dams.

b. Shingles and rolled roofing has the disadvantage of many seams which can be penetrated by water from ice dams or wind; they are not considered as durable as some metal roof systems.

c. Sod roofs will require maintenance during dry seasons.

d. Sod roofs also require a moisture barrier below that is not susceptible to corrosion from organic minerals or destruction from plant roots.

e. Exact locations of leaks are difficult to locate on sod roofs.

FLAT ROOFS:

a. Asphalt or elastomeric mopped roofs require special environmental conditions at the time of application which frequently is not available in certain rural conditions.

b. Mopped roofs also require specialized knowledge and equipment for application and repair which may not be available.

2. Structural Roof Assembly: In a cold roof assembly, the structural component generally consists of a plywood deck on trusses, rafters, beams, or joists. The structural components are designed to provide a surface for attachment of the exterior membrane and to distribute both deadloads, i.e., the load of the roof components above; and live loads, i.e., snow, wind, and seismic. When rigid insulation is used between the structural diaphragm and roof membrane, an acceptable fastening between the two skins is a common problem. Metal fasteners, or solid wood that penetrates the insulation and tie the two elements together, presents heat transfer problems.

3. Ventilated Air Cavity: The ventilated air cavity may typically perform two functions: 1) thermal isolation of the roof membrane; and/or vapor evaporation or sublimation of moisture susceptible insulation. The former is the adhering principle in a cold roof. (See Section 8.442). The latter is mandatory for fiberglass batt insulation. The above two functions may be used independently or together.

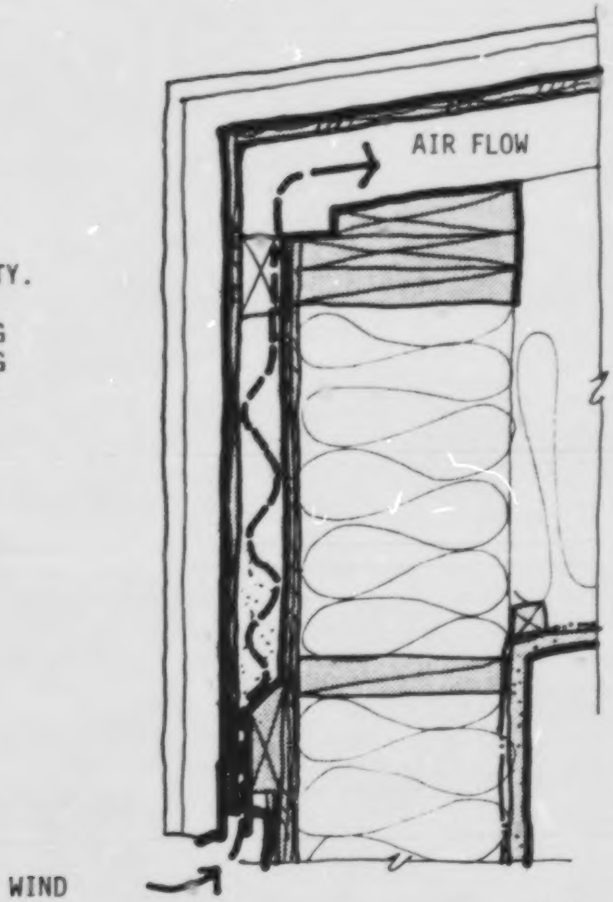
   Venting can be accommodated by ridge vents, eave vents, gable end-vents, or stacks. Ventilation can be accommodated passively utilizing natural or mechanically induced convection currents. Mechanical ventilation presents equipment maintenance, additional energy requirements, etc. Baffels may prevent blowing snow from entering the space. (See Figure 8.20). Firebreaks, draftstops, and structural members have to be taken into account in designing successful ventilation. The ventilation cavity can be sized so that it will not require sprinklering, and yet may have similar insurance benefits (see Section 5.25).

4. Insulation: (See Section 8.33).

5. Vapor Barrier: (See Section 8.34).

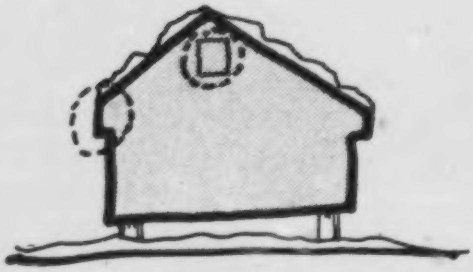
8.5 BUILDING ENVELOPE INTERIOR ELEMENTS: The interior building envelope must perform several functions: provide an aesthetically and functionally pleasing environment for human activities; surfaces to mount equipment; protect exterior building envelope elements from damage; protect and conceal mechanical and electrical systems (providing adequate access or exposure wherever possible); protect people and building elements with fire-resistive materials where required; and provide an easily maintained and sanitary wearing surface.

BAFFLED EAVE VENT:
BAFFLE AT BOTTOM OF EAVE VENT INCREASES AIR VELOCITY. AIR ENTERS LARGE CAVITY WITH BAFFLE AT TOP CAUSING AIR TO DECELERATE -DROPING AIR BORNE SNOW- BEFORE IT CAN ENTER ATTIC SPACE.

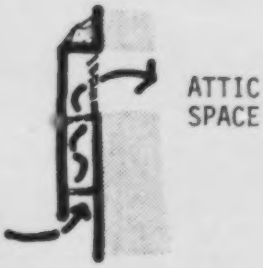


BAFFLED GABLE VENT
(SEE BELOW)

BAFFLED EAVE VENT
(SEE ABOVE)



BAFFLED GABLE VENT:
MULTIPLE BAFFLES SETTLE OUT AIRBORNE SNOW BEFORE IT CAN ENTER ATTIC SPACE.



BAFFLED ROOF VENTS

(FIGURE 8.20)

8.51 Interior Floors: The variety of activities in a typical school facility, and the climatic and site conditions outside the building, have a major impact on the selection of suitable floor finishes. (See Section 4 for detailed information on floor finish type recommendations for each activity). The objectives in selecting a suitable floor finish are: 1) easily maintained and repaired; 2) suitable for activities encountered; and 3) acoustic qualities (sound absorption). Some spaces such as multipurpose rooms, require a finish for a variety of activities, i.e., basketball, students sitting on floor, lunch programs, dancing, classroom activities, etc., as well as heavy mobile equipment and sound absorption qualities.

Other spaces may have less diverse activity requirements, but far more critical performance requirements, such as shower and toilet room floors which protect the floor system below from water damage.

8.52 Interior Wall Components: Interior wall components protect the vapor barrier, reflect light, provide vertical work surfaces, and and moisture and acoustic barriers. They also provide fire protection, a surface for attachment, equipment, and sanitary surfaces. (See Section 4). Interior wall coverings that are appropriate for school facilities include:

8.521 Gypsum Wallboard: Gypsum wallboard is a common noncombustible wall sheathing with many applications.

1. Use:

   a. Receives a variety of paint and sheet wall coverings.

   b. Provides a backing for other finishes such as wood or plastic laminate.

   c. Special moisture-resistant type gypsum board is available. It should not be used on the outside of exterior walls where moisture could become entrapped between the board and the wall system's vapor barrier.

   d. Used for various fireproofing applications.

2. Advantages:

   a. A very flexible material. Used for general wall sheathing, fire, and acoustic barrier depending on thickness, method of attachment, finish, and composition.

   b. A frequently used material; skilled labor readily available; flexibility with regard to future modification, repair, and refinishing; and economical because of its universal usage.

3. Disadvantages:

   a. Gypsum wallboard should be plywood backed where it may be subject to physical impact. Use of metal corner beads protects corners and edges from damage.

   b. Subject to deterioration when moist.

   c. Heavy shipping weight.

8.522 Fire-Retardant Treated Wood: Available in dimensional lumber shapes, composition, and plywood sheets for use when extra fire protection characteristics are desired or needed. Useful as a durable wall finish, finish trim, interior partition, studs, and wainscoting (with or without gypsum wallboard behind it) in halls, recreational spaces, toilets, and locker rooms.

1. Advantages:

   a. Durable; easily maintained and replaced.

   b. Water-resistant and fire-rated factory finished sheets ("Marlite Fire Panels") available.

2. Disadvantages:

   a. Not recommended in areas with high moisture.

   b. May require special attention to properly finish.

8.523 Tile: Glazed ceramic or quarry tile in grout bed on gypsum wallboard or plywood substrate.

1. Use: Wet areas.

2. Advantages:

   a. Easy to maintain; not easily damaged.

   b. Durable; long-life.

3. Disadvantages:

   a. Tile can make access to concealed systems difficult.

   b. Cold to the touch.

   c. Heavy to ship; expensive material cost; and special labor needed.

8.524 Acoustical Panels: Sound absorbing perforated mineral and/or fiberglass sound absorbing panels or tiles.

1. Use: May be applied over gypsum wallboard, but should be securely fastened (mechanical or adhesive) and be located above head height to protect from damage. Acoustical panels can be used to help absorb and diffuse sound in spaces such as shops, multipurpose rooms, corridors, or large open classroom areas.

2. Advantages:

   a. Common availability.

   b. Light-weight for transportation.

   c. Easily replaceable panels.

   d. Provides good accessibility to area covered.

3. Disadvantages:

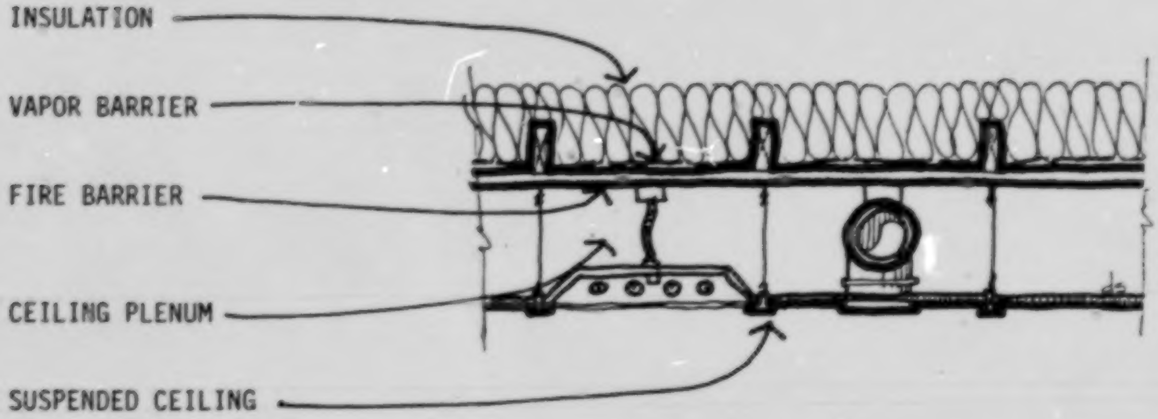
   a. Some panels not recommended in areas of high moisture, or where they may be accessible to physical impact.

   b. Skilled labor needed for installation.

8.53 Ceiling System: Ceiling components serves several functions: light reflection, acoustic absorption or diffusion, fire-break, vapor barrier protection, support of ceiling fixtures, and concealment of equipment and structure (aesthetic). Typical suspended ceilings, with acoustic tiles set in a grid, allow easy access to equipment concealed above, and replacement for damaged sections. New panels are easily shipped and stored for annual maintenance. Where all equipment is exposed, the finished ceiling may be acoustic tile on gypsum board or painted gypsum board. Standard acoustic tile ceilings are not recommended in shower rooms due to moisture damage. Coffered suspended ceiling systems can provide good acoustic absorption and diffusion, particularly in multipurpose rooms and large open classroom situations. (See Figures 8.21, and 8.22).

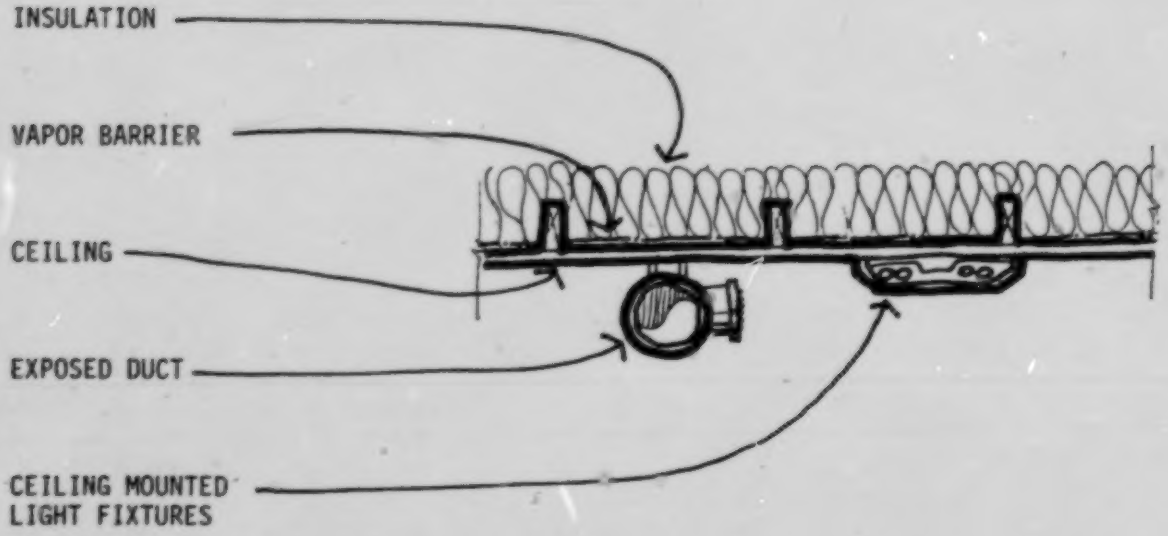
8.6 BUILDING ENVELOPE ARCHITECTURAL PENETRATIONS: Wherever a penetration is necessary, the envelope becomes exposed to all of the combined forces of local weather, regardless of the quality or type of envelope construction.

8.61 Windows: Windows affect building energy consumption and, therefore, are of great potential for energy conservation. The form and placement of windows should be guided by an awareness of their impact on energy conservation and creature comfort.


INSULATION
VAPOR BARRIER
FIRE BARRIER
CEILING PLENUM
SUSPENDED CEILING

CEILING SYSTEM 1

FIGURE 8.21


INSULATION
VAPOR BARRIER
CEILING
EXPOSED DUCT
CEILING MOUNTED LIGHT FIXTURES

CEILING SYSTEM 2

FIGURE 8.22

8.611 Placement: Windows should be positioned so that the inner pane is flush with the inner wall surface. This is to allow heat-washing of the glass and, therefore, minimizes frost build-up on the glass.

As the areas of glazing become smaller, placement becomes more important. While the south walls are the most desirable for locating windows, the long dark winters makes windows a liability with regard to energy consumption. Shades, blinds, or drapes should be mounted to allow warm air to pass directly over the glass for heat-washing. Place operable windows with regard to wind that may catch and damage an open pane.

8.612 Construction: An often used window has a premanufactured wood frame, usually metal or plastic clad. Window size variety within one building should be limited for simplified replacement and stocking of glazing.

Two basic types of glazing are used: insulated glass, and double glazing. Insulated glass is one piece, perimeter welded, with low humidity gas between panes. Double glazing is composed of single panes joined at the perimeter by placement in the frame. Air vent and moisture weep holes should be provided in the bottom of the frame between the panes and the building exterior in double glazed units. This allows moisture and moist air to escape to the exterior atmosphere and reduce fog and ice formation between the glass.

Triple pane with a center pane of acrylic sheet plastic can be used so that the window is not completely lost in case of an accident or vandalism. An alternate is to have two panes of glass and an acrylic sheet plastic storm windowpane on the outside. Heat loss characteristics are enhanced by this concept because of acrylic's superior R-value compared to glass. Acrylic sheet plastic is subject to defacing from abrasion, vandalism, blowing dirt, cleaning, and heat (melting). Installation of sheet plastic in stock window frames is complicated by a different coefficient of expansion from glass. When used in fixed windows, acrylic plastic sheet is difficult to use as an emergency means of egress because of acrylic's resistance to breakage.

Jamb heads and sills must be constructed with trims and stops to reduce the use of through-wall solid wood as much as possible, and sole reliance on sealants to prevent filtration of heat. Windows may also be provided with insulated shutters, shades, and screens.

8.613 Ventilation: Due to the desirability of reducing glazing areas, it is not thought to be practical to use windows for required ventilation. Casement or awning style operable windows provide good ventilation and flexibility with simple weatherstripping requirements. Operable windows with screens can provide temporary ventilation, particularly in classrooms where activities such as science, home economics, art, or shop may create occasional needs for extra ventilation, or when the mechanical system is not operable. Operable windows are also utilized for emergency egress (per NFPA 101, Section 9-2.12). Operable windows may freeze when in the open position. Outside air temperatures are often too severe to allow for comfortable air mixing within the room, and stain damage results from escaping interior vapor forming on the exterior siding.

8.62 Doors: A major maintenance problem in bush facilities has been repair and replacement of locks and doors due to incorrect specification of materials. Damage to doors, both exterior and interior, is most severe at latches, jambs, and closers. Doors which are susceptible to damage (requiring replacement or heavy post-construction external reinforcing) are: hollow wood, light gauge metal, foamed-in or gypsum filled wood veneer, and plastic laminate doors.

1. Use:

   a. Recommended doors for both interior and exterior use, due to durability and low thermal conductivity, are wood stave solid core doors. For interior use, heavy gauge metal is a good choice. Door specifier should seriously consider additional internal reinforcing around locks for all doors. Insulated hollow metal doors must be evaluated for use in extreme cold conditions. This type of door may tend to bow outward because of the different coefficients of expansion between the warm interior and cold exterior faces.

   b. Use of maximum size lights, allowable by UBC in classroom and other primary doors, should be considered by designers.

   c. Heavy-duty door frames of either wood or hollow metal are recommended. Use of fire-rated metal door frames throughout the building would minimize a later expense if rooms are utilized for another use in the future which might require a fire-rated assembly.

      Metal frames used at exterior openings shall be thermal break, galvanized frames filled with insulation. Wood frames over 7-1/2" deep shall be detailed to avoid cupping and warping. Frames shall be detailed to avoid through-joints, and reliance solely on sealants for protection from air filtration.

Double exterior doors should be equipped with (removable) center astragal to facilitate better weatherstripping and positive latch closing instead of relying on closers to provide adequate pressure, particularly in windy areas. If no overhead doors are installed in a facility, at least one building entry should have a removable center astragal for passage of bulk items. Also, one entry to the multipurpose room should be so provided.

d. Exterior doors shall include weatherstripping (suitable for temperature range and use encountered) around the entire perimeter of door. A five inch door knob backset on exterior doors allows for operation with mittens in cold weather. Arctic grade fluid should be specified for exterior door closers. Creative solutions that adequately address weatherstripping requirements and handicap access provisions should be considered.

8.7 BUILDING ENVELOPE MECHANICAL PENETRATIONS: A stock weather louver, when used alone on an outside wall, is inadequate for stopping wind driven snow. The driven snow will eventually melt within the building, and the resultant water can damage the interior finishes and the building envelope. Similarly, condensation on the surface of an uninsulated outside air intake, fuel oil line, or plumbing vent can cause water damage. A design which ignores the affect of penetrations by pipes, ducts, chimneys, etc., can become a disaster.

The following paragraphs explore commonly encountered mechanical penetrations in the building envelope, and attempt to identify proven solutions to these design situations.

8.71 Combustion Air: In any location where there is fuel burning equipment, a sufficient supply of air is required for proper fuel combustion, ventilation, and draft hood dilution. The volume of the spaces containing the fuel burning equipment for these schools is such that outside air is required. The quantity of air and the terminations of ductwork are determined in each case by interpretation of Chapter 6 of the Uniform Mechanical Code. In all cases, however, certain common design features should be incorporated.

1. Velocity: In locations where driving snow and/or rain are encountered, the entrance velocity of the air should be limited to 700 feet per minute. In extreme environments, 200-400 fpm is recommended.

2. Louvers: A weather louver is recommended at the envelope penetration. Louvers should be designed to catch and drain away airborne snow and rain.

3. Bird Screen: Bird screens are necessary to keep out birds, small animals, and airborne debris. Due to the tendency for screens to frost up during freezing weather, screen mesh should be no smaller than 3/4 inch square and be of galvanized wire. Access must be provided for periodic defrosting.

4. Drainage: Because it is virtually impossible to keep out all moisture in all cases, ductwork should be soldered water-tight wherever water may accumulate. The first several feet of ductwork should be sloped for water to drain outside, with suitable passages in the lower flange of the louver provided.

5. Insulation: All combustion air ductwork should be insulated to prevent condensation. The thickness of the insulation can be calculated for each case, although in most cases two inches of rigid fiberglass has proven effective. A complete and thorough vapor barrier must be provided over all insulation to keep it dry.

8.711 Floor Intake With Ductwork: (See Figure 8.23).

1. Advantages:

    a. This method of intake is well suited to equipment rooms in interior spaces. With the louver horizontal, there is no wind force to contend with.

    b. In addition, any moisture which may be sucked in will naturally drain out.

2. Disadvantages:

    a. This type of intake, although superior, is limited to buildings with elevated floors. This arrangement cannot be used for a building with floor slab-on-grade.

8.712 Floor Intake Without Ductwork: (See Figure 8.24).

1. Advantages:

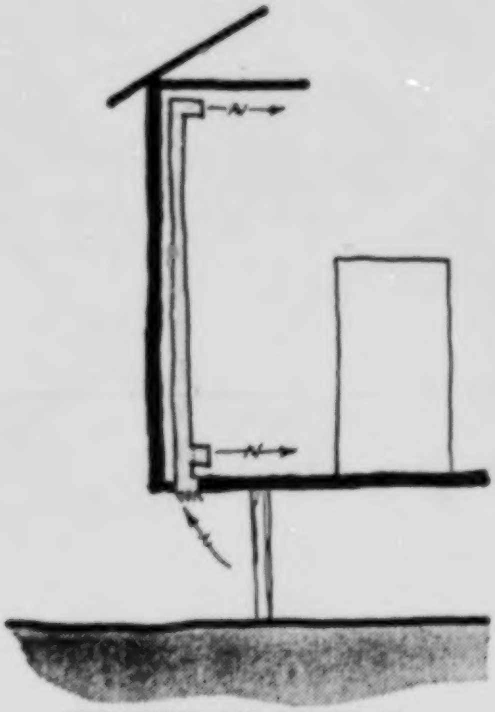
    a. This arrangement is suited to interior mechanical rooms in buildings with elevated main floors where space for combustion air ductwork is limited or unavailable.

2. Disadvantages:

    a. Large penetrations present a hazard for foot traffic.

    b. Drafts and cold spots with freezing at the floor are difficult to control.

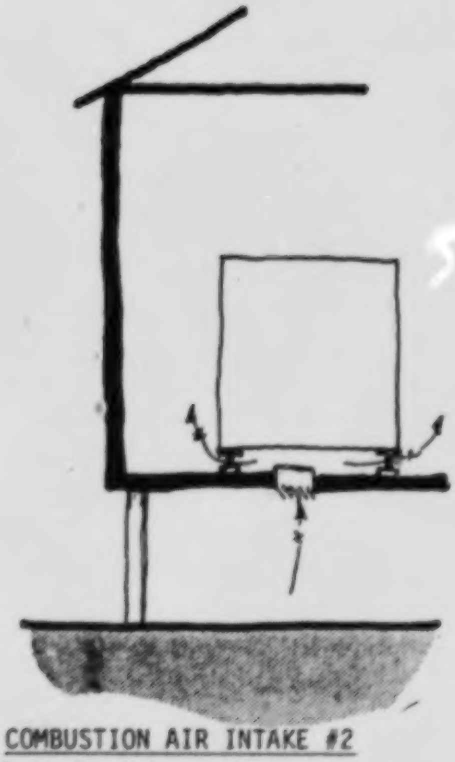
A. THORUGH FLOOR
B. STANDARD DUCT
C. STORM LOUVER IN FLOOR
D. 3/4" BIRD SCREEN



COMBUSTION AIR INTAKE #1

FIGURE 8.23

A. THOURGH FLOOR
B. UNDER FURNACE FOR PRE-HEATING AIR
C. STORM LOUVER IN FLOOR
D. 3/4" BIRD SCREEN



COMBUSTION AIR INTAKE #2

FIGURE 8.24

c. This method does not provide as efficient drainage as does the ducted alternative.

d. Not possible in buildings with floor slab-on-grade.

8.713 Soffit Intake: (See Figure 8.25).

1. Advantages:

a. This scheme may be used for both interior and exterior rooms. Like the intake through floor, the horizontal orientation of the louver prevents direct wind impingement. The intake is an invisible architectural element.

2. Disadvantages:

a. This arrangement is limited by the width of the soffit and the structure of the building at the wall roof juncture.

b. Intake velocity must be carefully considered due to reflection of wind off the vertical outside wall.

8.714 Wall Intake: (See Figure 8.26).

1. Advantages:

a. This is suited to buildings with slab-on-grade without a soffit. This is easier to install than a soffited intake.

2. Disadvantages:

a. Direct impingement of wind requires that a hood be provided which is not always a desirable architectural element. Standard hood arrangements present problems due to reflection of wind. Here, hood design and entrance velocity are critical.

8.715 Roof Intake With Gooseneck: (See Figure 8.27).

1. Advantages:

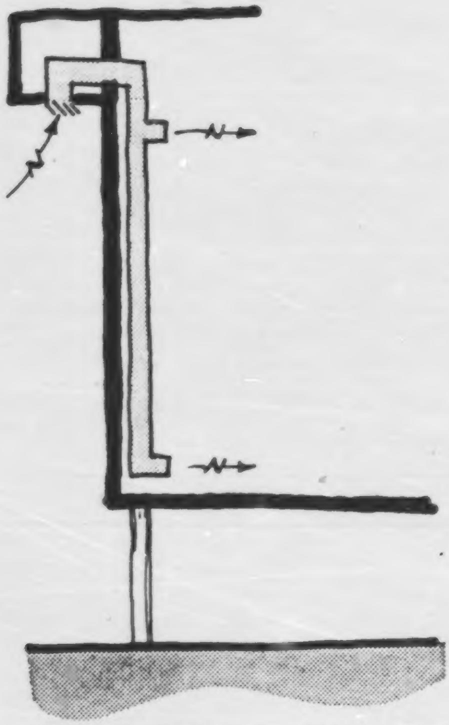
a. On interior mechanical spaces with floor slab-on-grade, this installation can provide cost savings in some cases.

b. This is best suited for flat roofs.

2. Disadvantages:

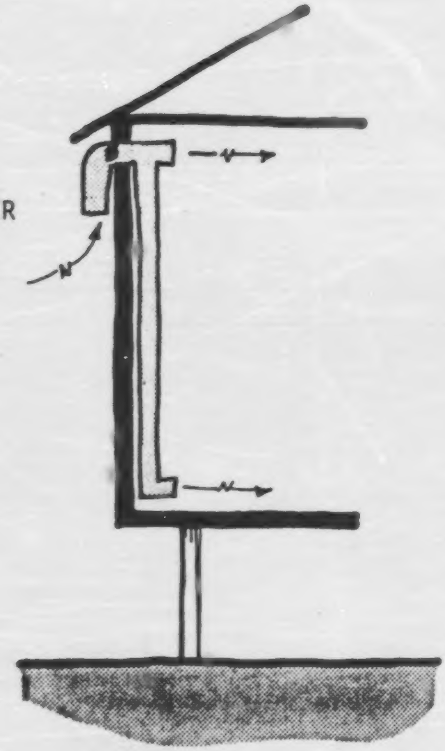
a. On sloped roofs, especially in areas with large snowfalls, the roof curb and ductwork become a trap for snow and ice.

A. INTAKE IN SOFFIT
B. STANDARD DUCT
C. STORM LOUVER
D. 3/4" BIRD SCREEN



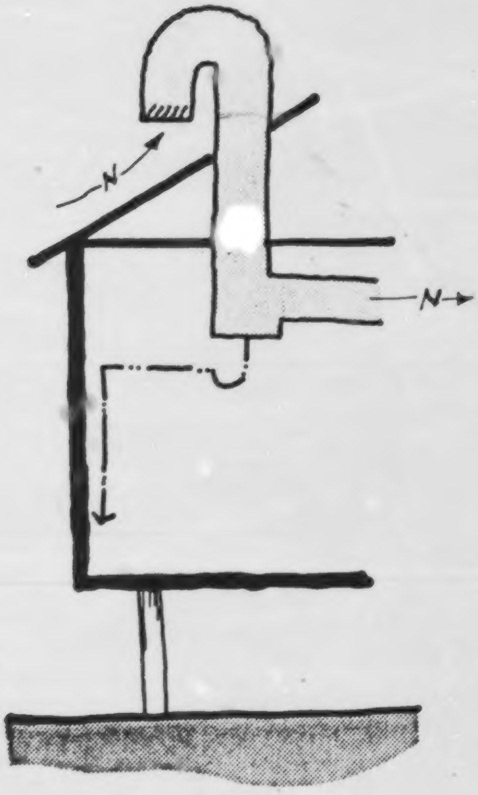
COMUBUSTION AIR INTAKE #3
FIGURE 8.25

A. THROUGH WALL
B. HOOD DOWN OUTSIDE WALL 3 X LOUVER
   DIMENSION
C. STORM LOUVER
D. 3/4" BIRD SCREEN



COMBUSTION AIR INTAKE #4
FIGURE 8.26

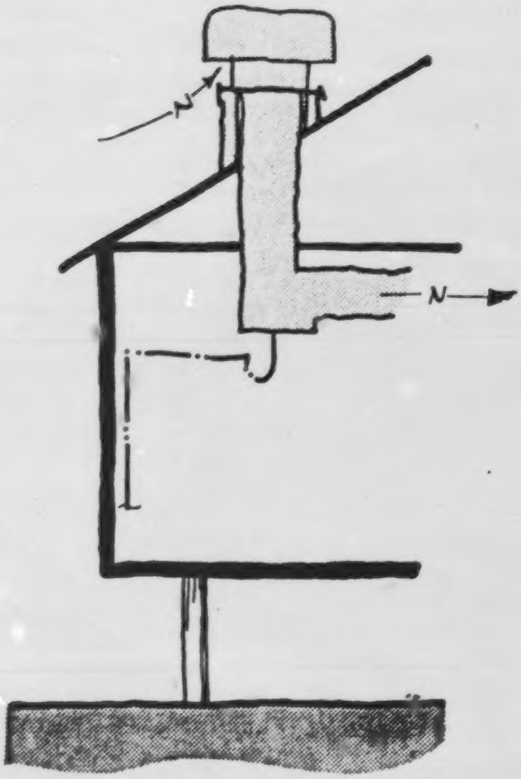
A. THROUGH ROOF
B. WATER TIGHT SUMP WITH DRAIN
C. BIRD SCREEN
D. INSULATION



COMBUSTION AIR INTAKE #3

(FIGURE 8.27)

A. THROUGH ROOF
B. ROOF CURB & CAP
C. WATER TIGHT SUMP WITH DRAIN
D. INSULATION



COMBUSTION AIR INTAKE #4

(FIGURE 8.28)

b. Freeze-thaw cycle forces can cause the roof curb to be damaged, resulting in roof leakage.

c. In areas with high winds, oversizing required for proper inlet velocity increases the net surface area and, thus, the resultant wind force encountered.

d. Also, the gravity affect of dense cold air creates problems of air quantity control.

e. Because the gooseneck must be custom fabricated, cost can also become a problem.

f. Overall, this method should be discouraged, especially in areas with extreme weather conditions.

8.716 Roof Intake With Skycap: (See Figure 8.28).

1. Advantages:

a. Can be used for interior rooms with slab-on-grade.

b. Cost of prefabricated skycap is usually less than for gooseneck.

2. Disadvantages:

a. On sloped roofs, the curb becomes a trap for snow and ice.

b. In areas with heavy snow, the cap can easily become buried, even on modest slopes, and can be sheared off by heavy snows.

c. Roof leaks are a problem. In windy areas, extra structural support may have to be provided.

d. The gravity affect of dense cold air creates problems with air quantity control.

e. Overall, this method of air intake should be discouraged, especially in areas with extreme weather conditions.

8.72 Ventilation Air Intake, Exhaust, and Relief: Whenever a building has toilet exhaust fans, furnaces, or circulating air requirements (for any reason), it is necessary to bring in air from the outside and then remove the air through the building envelope. The necessary air quantities for each space, and the building as a whole, are dependent upon code requirements, space usage, occupant loading, and experience of the designer.

Of primary code consideration are the location of air intakes and exhausts relative to each other, to chimneys, doors, windows, plumbing vents, and the surrounding environment. As a general rule, the lower the air quantity the lower the electrical and heating cost will be, in addition to a possible first cost savings in equipment, materials, and installation.

Methods of bringing in outside air and exhausting this air through the building envelope are similar to those for handling combustion air. (See previous discussion). Where air is being brought in from outside, the common design features of a combustion air intake should all be incorporated including low intake velocity, louver, bird screen, drainage, and insulation. In addition, all intakes should be provided with a motorized damper to prevent air flow during the system "off" cycle. (See Section 5.47 for combustion air ductwork discussion). Exhaust air penetrations should incorporate all of these features except that the air discharge velocity to atmosphere is not critical. An option to a motorized damper is possible for exhaust penetrations by using a gravity backdraft damper. Backdraft dampers should be carefully selected to operate fully open under fan design static pressure, and should be unaffected by cold during the "off" cycle.

Relief air penetrations are usually sized by velocity and by nature are not ducted. In effect, these can be treated similar to combustion air intakes. Due to cold infiltration during the off cycle of the supply system, which can cause localized condensation and freezing of pipes, the location of all relief penetrations should be carefully considered.

8.721 Intake Through Wall With Outside Plenum: (See Figure 8.29).

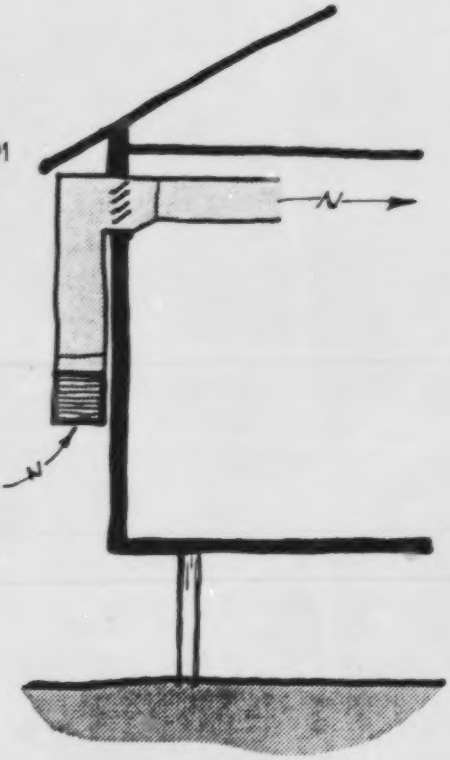
1. Advantages:

   a. When sized at 400 fpm or less in the riser, this type of intake is the most foolproof, even in extreme environments. It will not draw in snow or rain, regardless of wind direction or speed, because the riser velocity is not great enough to overcome the gravitational affect on rain and snow particles. With the bottom section of the plenum sloped from the center in both directions, the plenum becomes self-draining and self-cleaning. When used as a canopy over a door, it can be architecturally hidden.

2. Disadvantages:

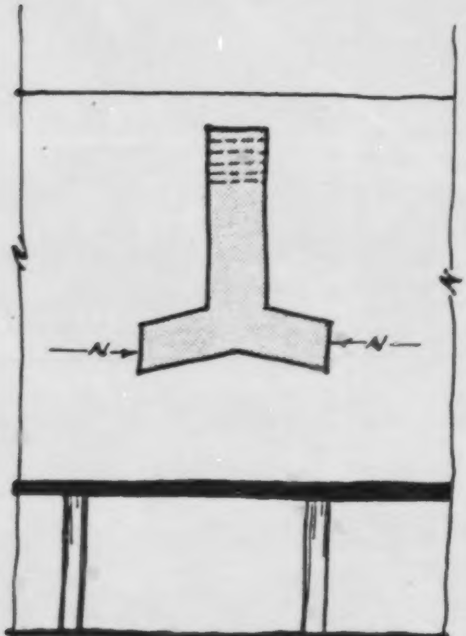
   a. Due to the low air velocity required, the large size of the plenum becomes a significant architectural consideration and cost. All materials in the airstream must be noncombustible (one-hour). If not high enough off the ground, it may be an attractive nuisance for children.

A. THROUGH WALL WITH OUTSIDE PLENUM
B. STORM LOVER
C. BIRD SCREEN
D. WATER TIGHT CONST. INSIDE BLDG.
E. SLOPE TO OUTSIDE
F. INSULATION



OUTSIDE AIR INTAKE #1

FIGURE 8.29



ELEVATION

8.722 Through Roof With Gooseneck: (See Figure 8.30). For discussion, see Section 8.715.

8.723 Through Roof Over Edge: (See Figure 8.31).

1. Advantages:

   a. This installation is less susceptible to wind than a gooseneck, and if sized for low velocity, will draw in less snow and rain.

2. Disadvantages:

   a. Windows are often encountered on the exterior wall, too close to allow this method within code limitations.

8.724 Through Roof With Skycap: (See Figure 8.32). For discussion, see Section 8.716.

8.725 Intake Through Floor With Adjacent Return Air: (See Figure 8.33).

1. Advantages: For discussion, see Section 8.711.

2. Disadvantages:

   a. See Section 8.711.

   b. Also, with the outside air so close to the return air, the possibility of condensation and frosting at the outside damper is increased. If this damper ices up during the system "off" hours, damper linkages may be bent or broken by the damper motor during start-up. Over a long weekend or winter holiday, the icing may extend into the louver which increases the difficulty of thawing.

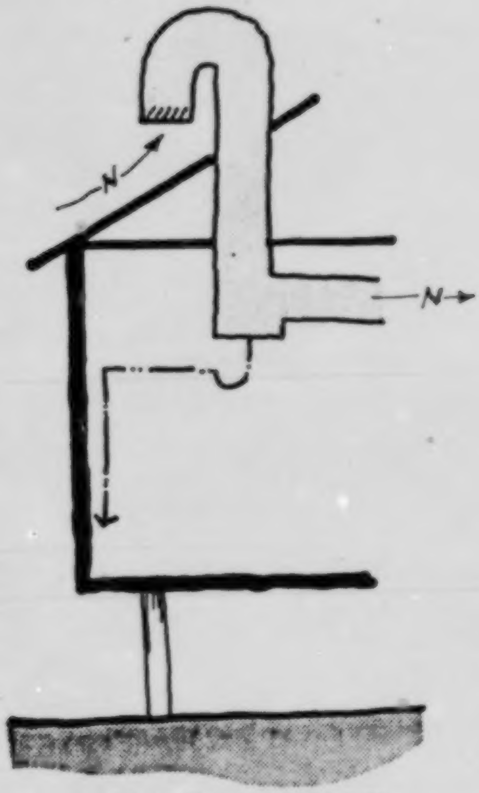
8.726 Through Wall With Hood: (See Figure 8.34). For discussion, see Section 8.713.

8.727 Intake Through Floor With Opposed Return Air and Intermediary Drip Pan: (See Figure 8.35).

1. Advantages:

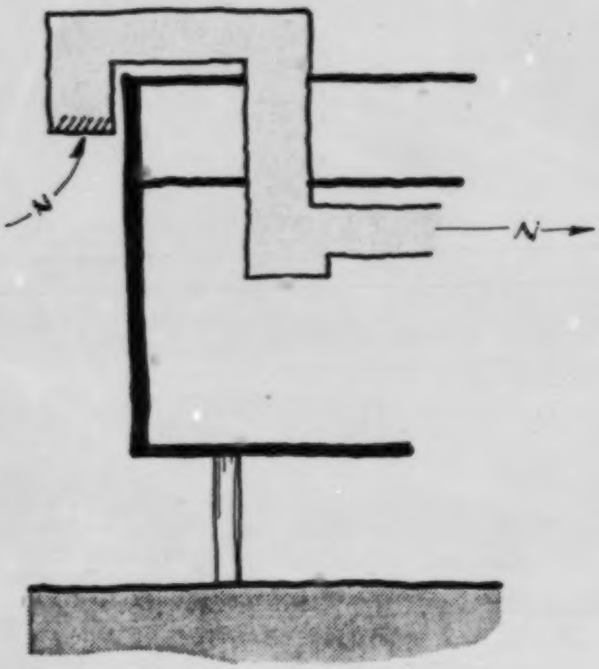
   a. See Sections 8.711 and 8.725.

A. THROUGH ROOF
B. WATER-TIGHT SUMP WITH DRAIN
C. BIRD SCREEN
D. INSULATION



OUTSIDE AIR INTAKE #2

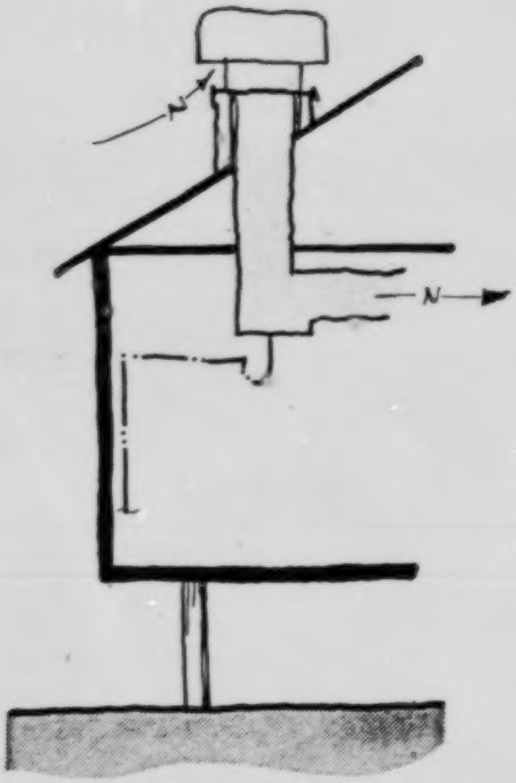
FIGURE 8.30



OUTSIDE AIR INTAKE #3

FIGURE 8.31

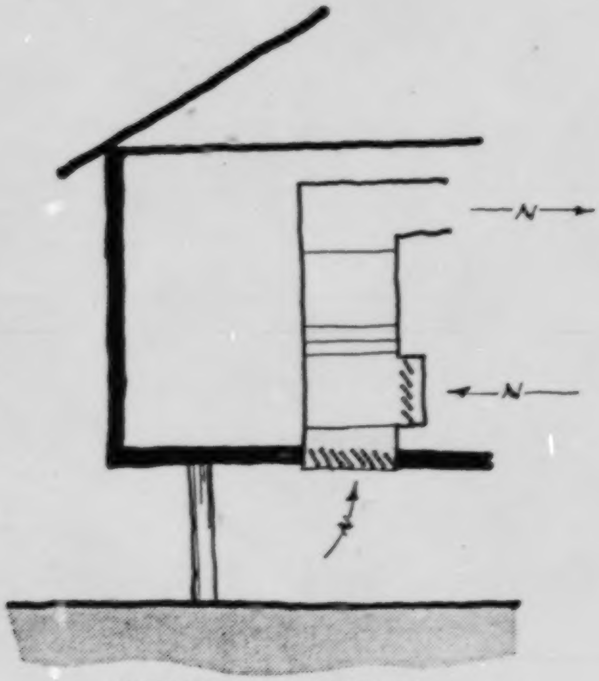
A. THROUGH ROOF
B. ROOF CURB AND CAP
C. WATER-TIGHT SUMP WITH DRAIN
D. INSULATION



OUTSIDE AIR INTAKE #4

FIGURE 8.32

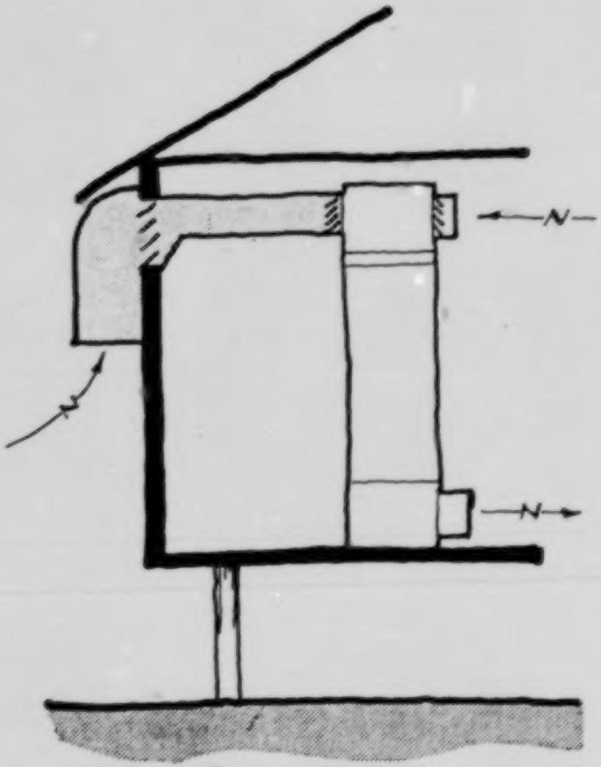
A. THROUGH FLOOR
B. DIRECT CONNECTION TO MIXING
BOX OR FURNACE
C. STROM LOUVER
D. 3/4" BIRD SCREEN



OUTSIDE AIR INTAKE #5

FIGURE 8.33

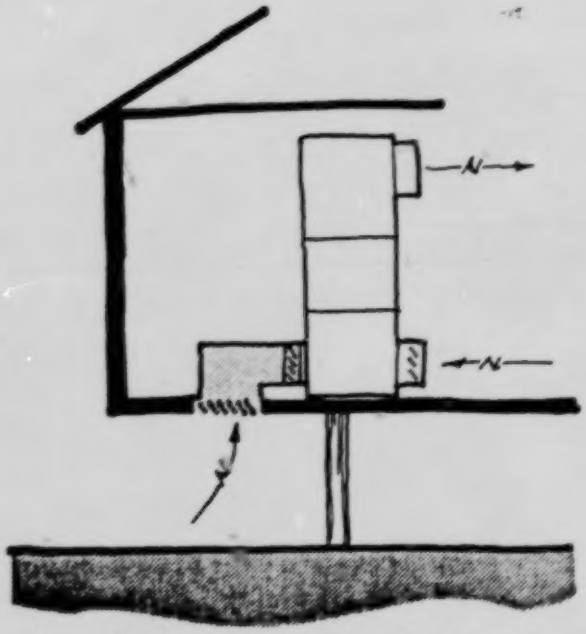
A. THROUGH WALL
B. LONG HOOD, LOW AIR VELOCITY
C. STORM LOUVER
D. BIRD SCREEN
E. DUCT SLOPE TO OUTSIDE
F. WATER-TIGHT CONSTRUCTION
G. INSULATED



OUTSIDE AIR INTAKE #6

FIGURE 8.34

A. THROUGH FLOOR
B. DUCTED
C. STORM LOUVER
D. BIRD SCREEN



OUTSIDE AIR INTAKE #7

FIGURE 8.35

b. In addition to the advantages of coming from the underfloor, this method eliminates some frosting and condensation problems inherent with having the outside and return openings close together. With the outside louver away from the damper, danger of icing the louver is greatly reduced. Any condensation which occurs on the outside damper or duct walls will be collected by the intermediate drip pan, and will eventually evaporate.

2. Disadvantages: For discussion, see Section 8.711.

8.728 Through Canopy or Soffit - Unducted: (See Figure 8.36).

1. Advantages:

a. Sizing the intake velocity through the soffit very low will result in a system little affected by wind and not prove to draw in snow or rain.

b. The canopy or soffit, itself, becomes a plenum; therefore, the duct connection and lower location is somewhat flexible.

2. Disadvantages:

a. As a plenum, the interior soffit construction must be noncombustible (one-hour).

b. Also, the soffit construction must be made to anticipate some moisture accumulation; materials should be designed to resist water damage and installed to drain.

c. Loose batt insulation is susceptible to moisture accumulation so its placement must be carefully considered.

8.729 Through-wall With Updraft Ductwork (Where Hood is not Permitted): (See Figure 8.37).

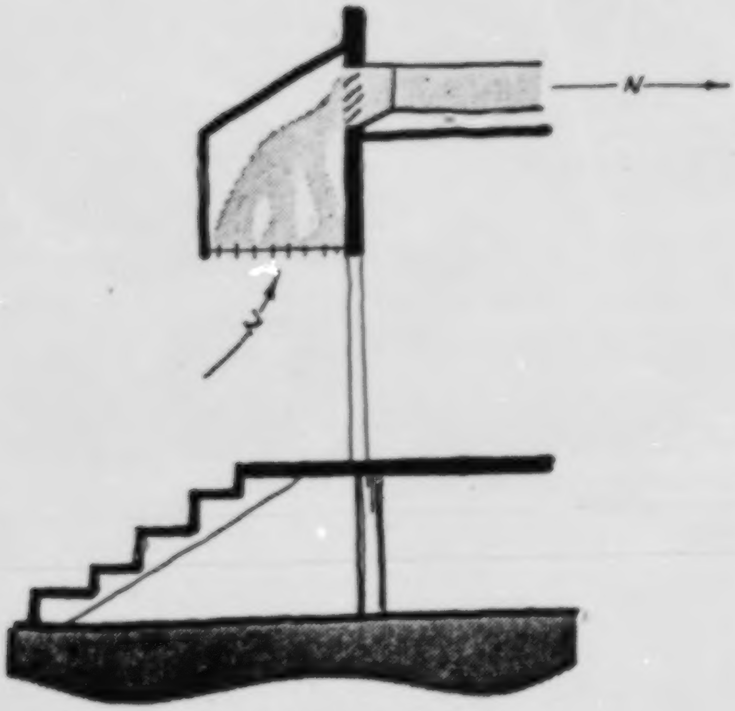
1. Advantages:

a. If located in an area somewhat sheltered from the wind, use of a hood can be eliminated.

b. Initial cost is lower, and there are some advantages of appearance.

c. It becomes very important to have water-tight ductwork which drains to the outside.

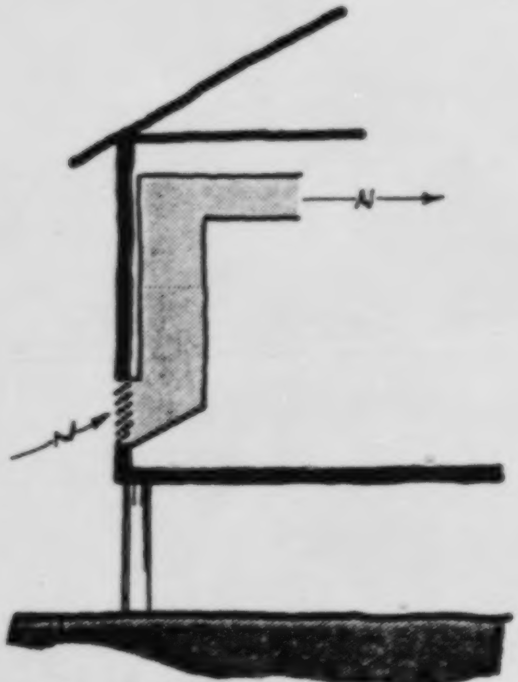
A. THROUGH CANOPY OR SOFFIT
B. ARCHITECTURAL LOUVER AND STORM LOUVER



OUTSIDE AIR INTAKE #8

FIGURE 8.36

A. THROUGH WALL (WHERE HOOD NOT PERMITTED)
B. LOW INTAKE WITH DUCT RISE



OUTSIDE AIR INTAKE #9

FIGURE 8.37

2. Disadvantages:

   a. This type of installation is easily misused and should be avoided whenever possible.

   b. Driving wind can easily plug the intake with snow.

   c. If connection of the duct to the louver is not completely water-tight, water leakage into the wall can result in ice damage, rot, and damage to interior finishes.

8.73 Plumbing Vents: Plumbing vents are necessary wherever there is a gravity drainage system within the building. By code, the drainage vent lines must terminate above the roof of the building. Also, vent lines must be continuously graded upward, without traps for water. Due to the limitation of routing possibilities, two alternatives are possible for penetrating the building envelope.

The most common method of vent termination is to go straight up through the roof. This method is by far the easiest, and has the advantage of limited vapor condensation and freezing within the pipe. Because there will be some frosting, the vent line should be increased two pipe sizes, a minimum of one foot below the roof, before penetration. In addition, the vent pipe must be insulated three feet inside the building (minimum) to prevent condensation on the outside pipe surface.

Disadvantages of the vent through the roof method become apparent in areas of high snow build-up and where ice may accumulate around the vent flashing. In areas with a heavy snow load on a sloped roof, sliding snow can shear off the vent. Where water is allowed to accumulate around the flashing, the pipe can be jacked up by the same mechanism which causes frost jacking in pilings. Also, where the roof assembly is designed to slide in compensation for thermal expansion and contraction, the vent can be sheared by the roof itself. In cases of jacking and shearing, even if the pipe remains functional, leaks in the roof are likely to develop at the penetration.

An alternative to the vent through the roof method is to go through an exterior wall and then up to above the roof with piping supported from the wall. This method has the advantage of being unaffected by roof expansion and contraction, and if on the end of the building, will not be damaged by sliding snow.

The disadvantage of this alternative, aside from the obvious architectural problems, is primarily the susceptibility to freezing of vapor within the pipe. The longer the run of pipe outside the building, the more likely vapor is to freeze. For this reason, all the exterior piping, in addition to piping three feet inside the building, must be insulated. Also, the pipe size must be increased two sizes larger to allow for some frost build-up which increases the cost. It is also advisable to consider the installation of electric heat trace for thawing the vent during colder weather. The entire exterior assembly should be encased in metal jacketing to reduce potential damage to the insulation.

8.74 Chimneys and Vents: A chimney and vent penetration is encountered whenever a furnace or boiler using a combustible fuel is used to supply a building's heating demands. The purpose of the chimney and vent is to convey unwanted flue gases to the exterior of the building for dilution into the atmosphere. Chimney and vent size is determined by the capacity rating of the equipment and the venting arrangement. It is not recommended to manifold chimneys from oil-fired heat producing equipment because of possible back pressure problems. All chimney and vent clearances should meet code requirements and manufacturers' recommendations. It is of extreme importance to cap the chimney or vent and flash the penetration to prevent moisture from traveling down the inside and outside of the chimney.

8.741 Through-the-Wall Exposed: (See Figure 8.38).

1. Advantages:

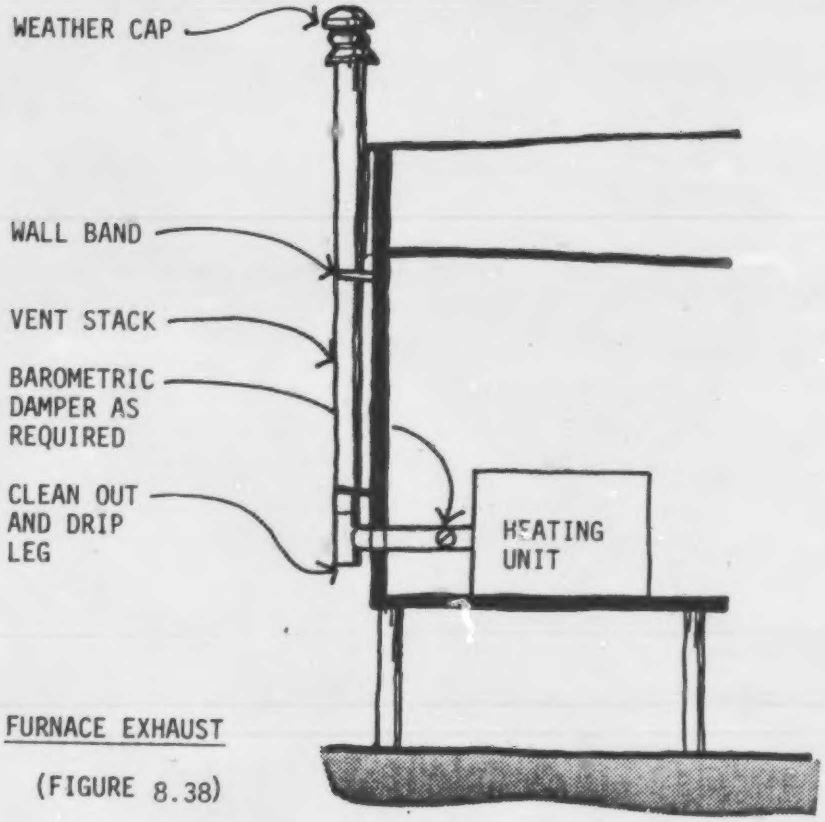
   a. This method provides for ease of installation through use of wall support brackets and provides for a means of installing a cleanout and drip leg.

   b. Roof penetrations and their associated problems are eliminated because a wall penetration is all that is required. A wall penetration is easier to seal than a roof penetration.

2. Disadvantages:

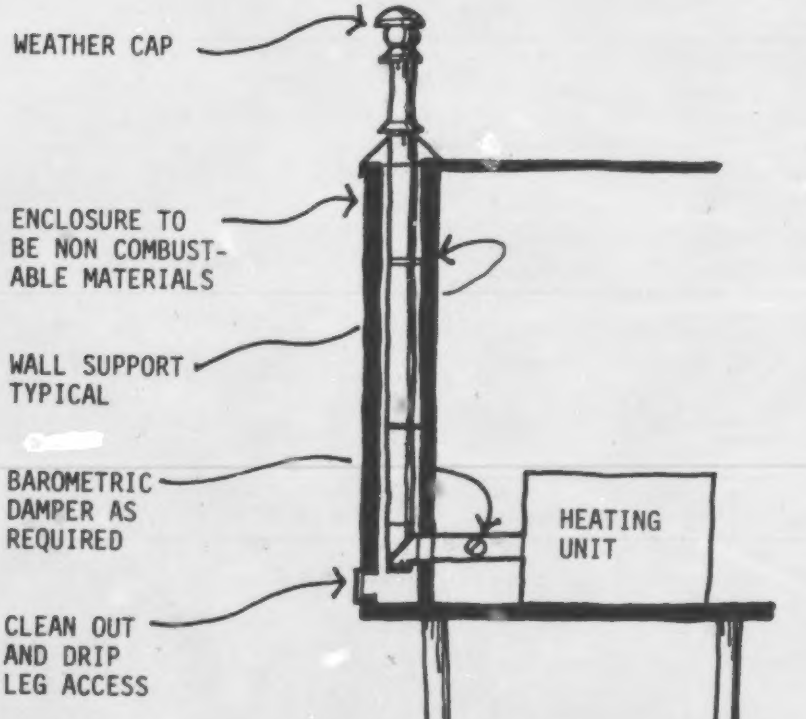
   a. Installing an exposed vent or chimney on the outside building wall allows for possible condensation problems which will deteriorate draft efficiency.

   b. The exposed vent or chimney will also be susceptible to external damage and destruction from vandalism or accidental impact from vehicles.


WEATHER CAP
WALL BAND
VENT STACK
BAROMETRIC DAMPER AS REQUIRED
CLEAN OUT AND DRIP LEG
HEATING UNIT

FURNACE EXHAUST

(FIGURE 8.38)


WEATHER CAP
ENCLOSURE TO BE NON COMBUSTABLE MATERIALS
WALL SUPPORT TYPICAL
BAROMETRIC DAMPER AS REQUIRED
CLEAN OUT AND DRIP LEG ACCESS
HEATING UNIT

FURNACE EXHAUST

(FIGURE 8.39)

8.742 Through-the-Wall Enclosed: (See Figure 8.39).

1. Advantages:

   a. This method has all the same advantages as Section 8.742.

   b. It also has the advantage of being protected from vandalism, and condensation problems are minimized due to the insulation valve and wind protection provided by the surrounding enclosure.

2. Disadvantages:

   a. The major disadvantage is the cost factor for building the protective enclosure because of its special construction.

8.743 Inside Offset Through-the-Roof: (See Figure 8.40).

1. Advantages:

   a. An offset in the chimney or vent allows for installation of the cleanout and drip leg, and coordination with the structural framing above.

   b. The offset may be used for either top or side outlet equipment.

2. Disadvantages:

   a. Roof-mounted chimneys and vents are susceptible to damage and clogging from large amounts of snow collecting on the roof.

   b. Leakage at the roof penetration can be a problem.

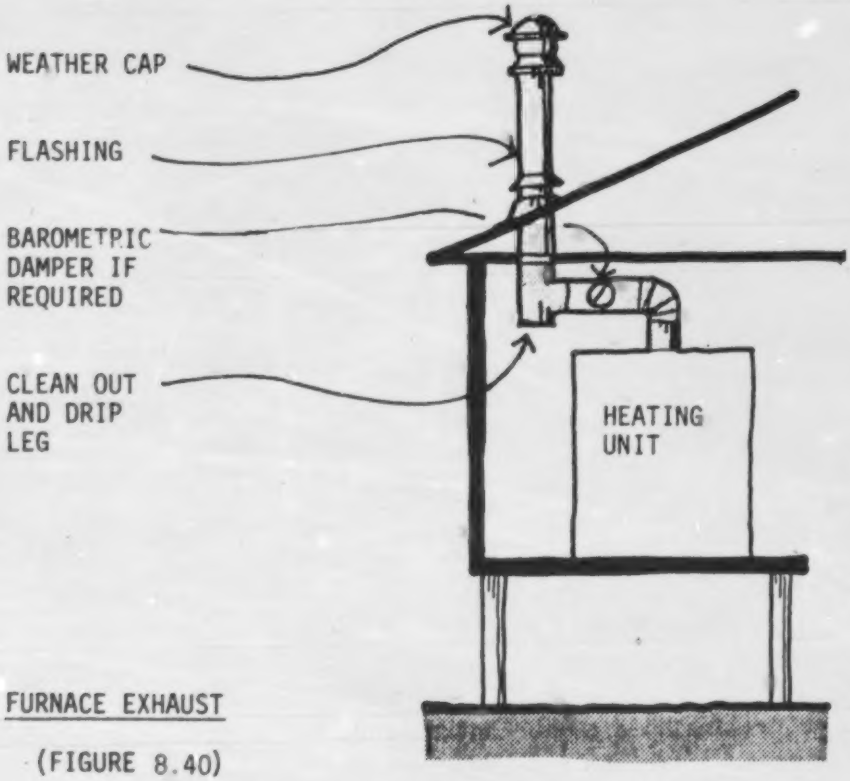
   c. Where there is ice build-up, jacking may occur.

8.744 Through-the-Roof Peak: (See Figure 8.41).

1. Advantages:

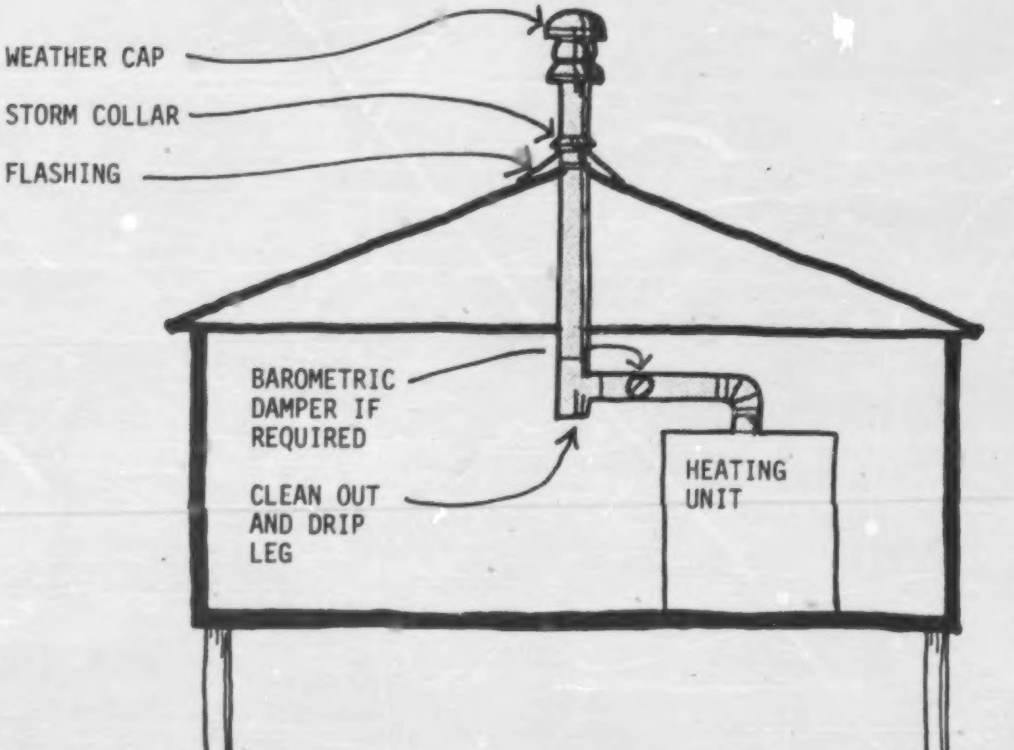
   a. This method may only be used on steel framed buildings where chimney or vent stack may go between roof joists.

   b. Because snow and rain will not collect at the roof peak except under extreme weather conditions, this method allows for a chimney or vent free of snow, and minimal (if any) moisture problems.


WEATHER CAP
FLASHING
BAROMETRIC DAMPER IF REQUIRED
CLEAN OUT AND DRIP LEG
HEATING UNIT

FURNACE EXHAUST

(FIGURE 8.40)


WEATHER CAP
STORM COLLAR
FLASHING
BAROMETRIC DAMPER IF REQUIRED
CLEAN OUT AND DRIP LEG
HEATING UNIT

(FIGURE 8.41) FURNACE EXHAUST

2. Disadvantages:

   a. Because the chimney or vent is penetrating the roof peak, a chase may need to be provided, depending on equipment location, for the chimney or vent to exit.

   b. Additional materials will also be required because of exiting at the roof's highest point.

8.75 Piping Penetrations: This section includes miscellaneous piping which penetrates the building envelope. Installation of piping in exterior walls and cold spaces should be avoided to prevent freezing problems. It should be noted that cold water lines in the interior of the building should be insulated to prevent condensation. Thermal expansion, sleeving, and caulking are important factors to consider on piping penetrating a building's envelope to prevent pipe breakage and infiltration.

8.751 Generator Engine Exhaust: The generator exhaust pipe is used to convey engine exhaust fumes from the generator to the exterior of the building. A thimble should be used where the exhaust pipe penetrates the wall or roof. Depending upon conditions, the pipe should be totally insulated or insulated a minimum of three feet back from the exterior wall to prevent condensation.

1. Through-the-Wall Exhaust: (See figure 8.42).

   a. Advantages:

      1) This is the preferred method for installing generator exhaust. The exhaust pipe can be sloped to drain outside.

      2) A wall penetration is preferred over a roof penetration.

   b. Disadvantages:

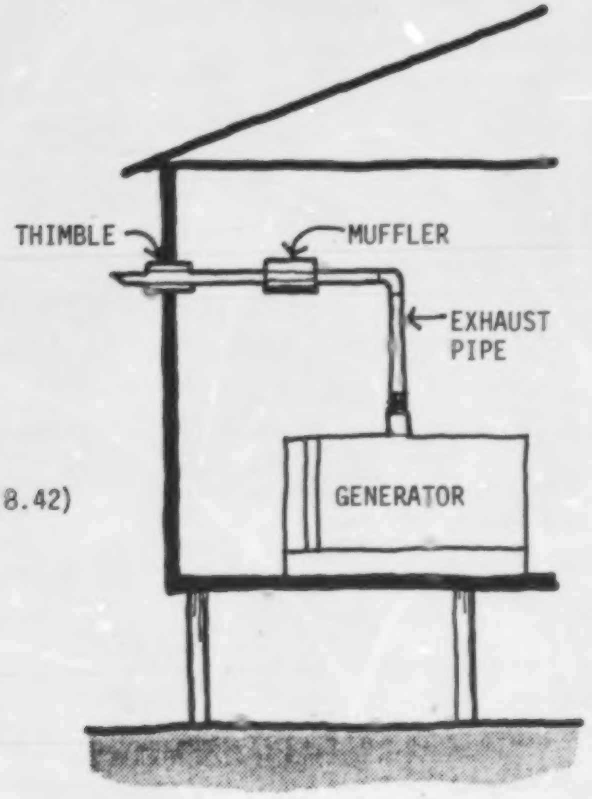
      1) Care must be taken in directing the generator exhaust.

      2) Noise transmission should be considered.

2. Through-the-Roof Exhaust: (See Figure 8.43).

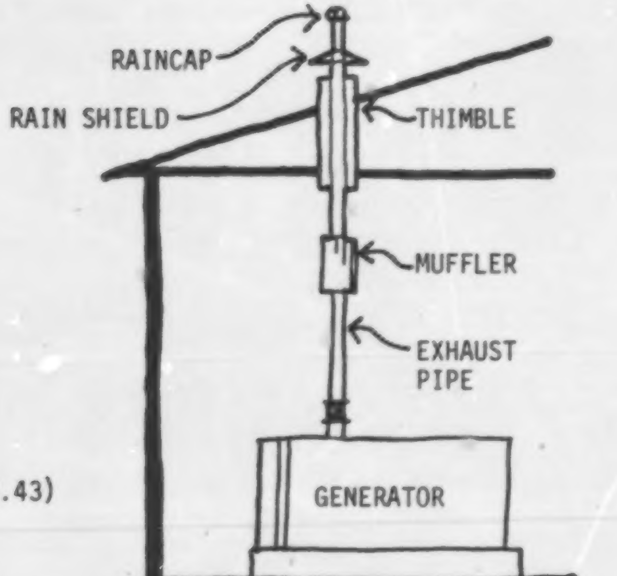
   a. Advantages:

      1) The noise will be directed up and, therefore, becomes less of a nuisance.


THIMBLE
MUFFLER
EXHAUST PIPE
GENERATOR

(FIGURE 8.42)

GENERATOR EXHAUST


RAINCAP
RAIN SHIELD
THIMBLE
MUFFLER
EXHAUST PIPE
GENERATOR

(FIGURE 8.43)

GENERATOR EXHAUST

b. Disadvantages:

1) The exhaust pipe is now susceptible to be covered by snow.

2) A roof penetration is difficult to prevent moisture entry into the building.

3) The exhaust pipe must be offset to provide a drip leg.

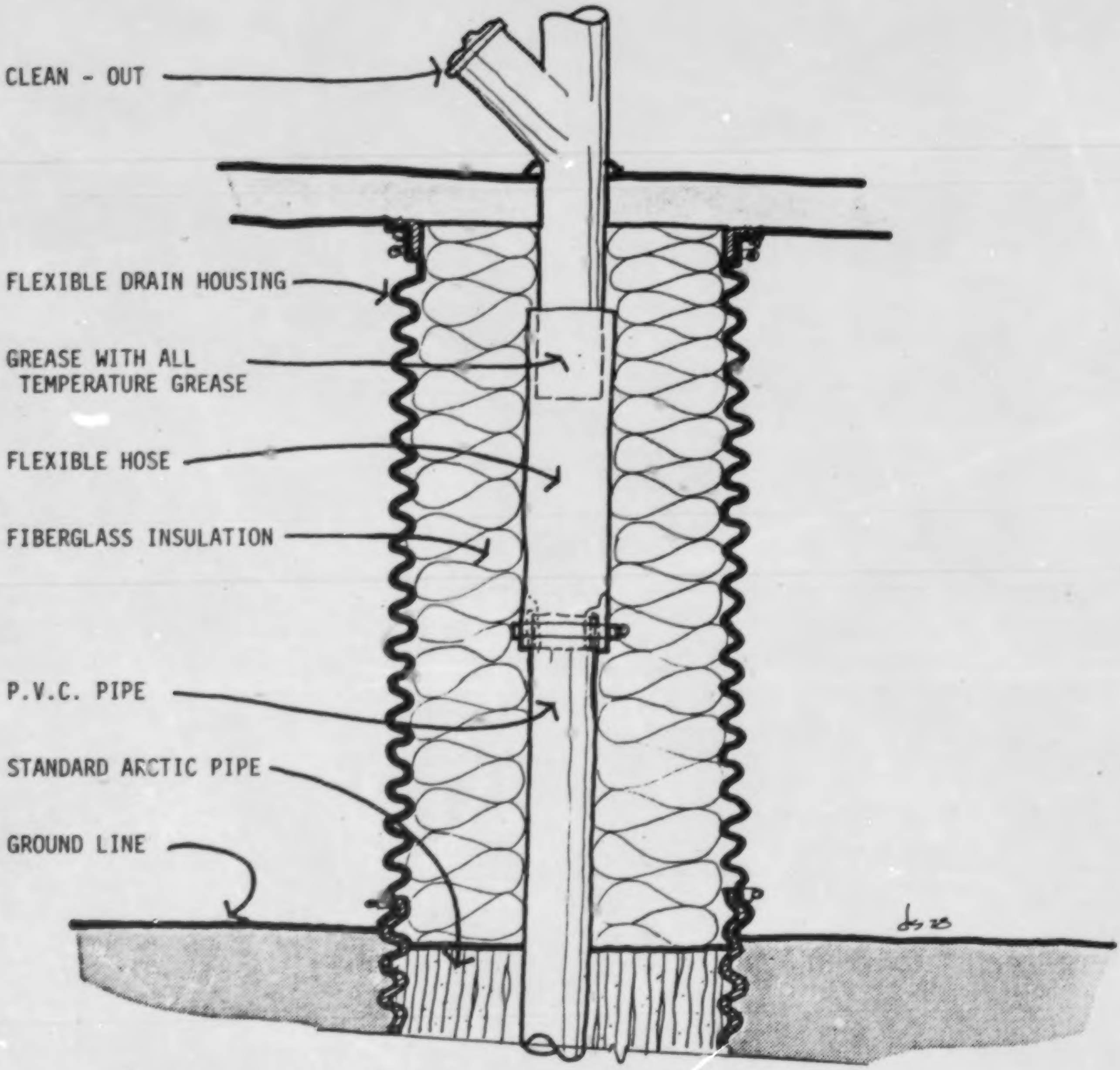
8.752 Exterior Wall Hydrant: Hydrants should be of the nonfreeze type, and the wall penetration should be well sealed to prevent air infiltration.

8.753 Building Drains: Where buildings are built slab-on-grade or on pilings or posts, building drains are invariably routed through the building floor.

1. Slab-on-Grade Construction: Where the drain can be installed below the frost line, installation can be made in the conventional manner without further consideration. Where freezing may be a possibility, the line should be insulated and heat traced. Once out of the building, the line may be treated as discussed in Section 6.

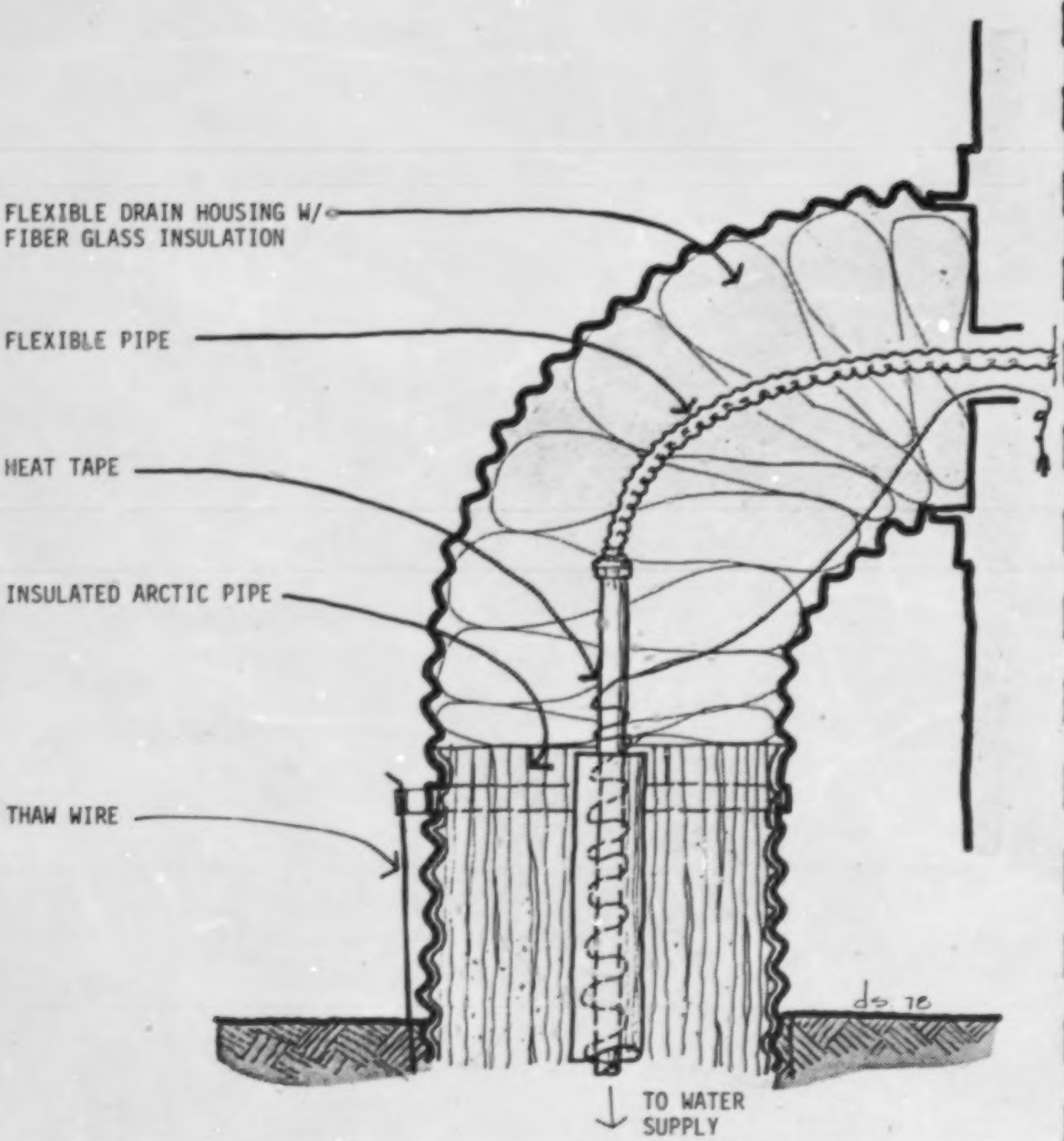
2. Elevated Buildings: The piping between the building and the ground must be made flexible to prevent breakage due to frost heave. One successful method of connection has been to connect the building drain into the bell end of an oversized section of sewer pipe from below ground, using a long section of rubber pipe. This pipe must be inserted into the sewer pipe a couple of feet to allow for vertical movement. Horizontal movement is compensated for by the rubber pipe. To prevent freezing, the entire assembly is encased in an insulated culvert, with a free space provided for differential pipe motion. In addition, a thaw wire or electric heat tape should be provided. (See Figure 8.44).

8.754 Water Service: The basic considerations of source and method are discussed in Section 6. Connection to the building is similar to connection of the building drain, and the same considerations apply. Generally, the service enters the building through the floor. Considerations for freezing must be made. Generally, including insulation and the installation of thaw wires and/or heat tape is recommended. For buildings with exposed underfloors, a method similar to that described in Section 8.753 is recommended. Where rubber pipe was shown for the sewer connection, a coil (or coils, if the system is the circulating type) of soft drawn copper tubing may be substituted. (See Figure 8.45).


CLEAN - OUT
FLEXIBLE DRAIN HOUSING
GREASE WITH ALL TEMPERATURE GREASE
FLEXIBLE HOSE
FIBERGLASS INSULATION
P.V.C. PIPE
STANDARD ARCTIC PIPE
GROUND LINE

TYPICAL BUILDING SEWER-FLOOR CONNECTION

(FIGURE 8.44)


FLEXIBLE DRAIN HOUSING W/ FIBER GLASS INSULATION
FLEXIBLE PIPE
HEAT TAPE
INSULATED ARCTIC PIPE
THAW WIRE
ds 78
TO WATER SUPPLY

TYPICAL BUILDING WATER CONNECTION

(FIGURE 8.45)

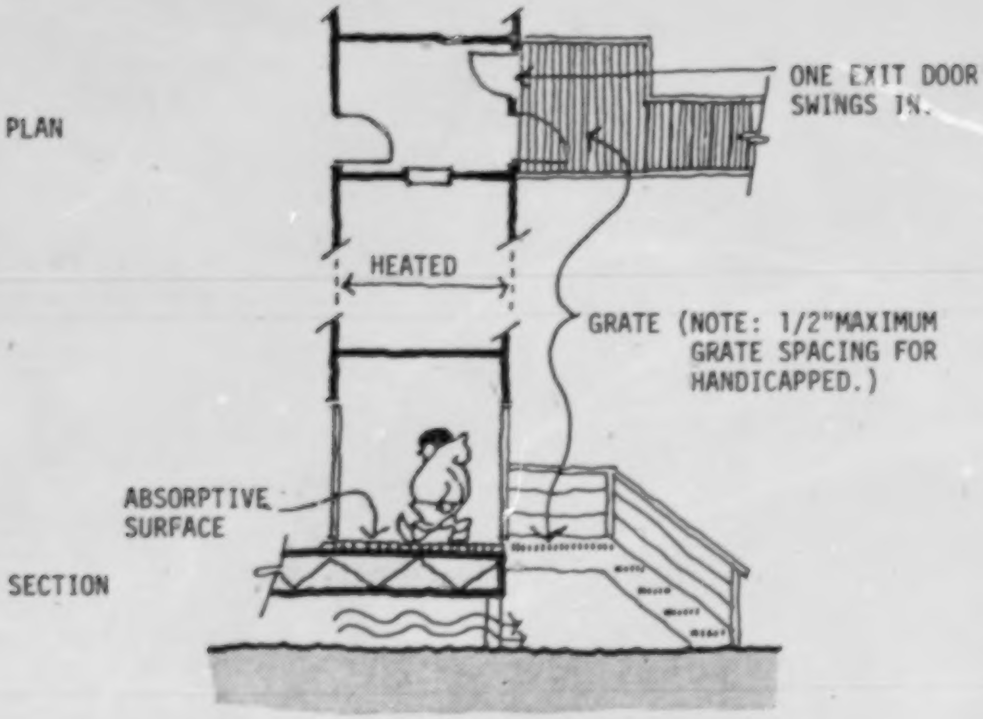
8.8 ENTRIES: The design of entries affects not only the accessibility for people and goods, but also the maintenance of the building and the potential amenities it provides.

Use: A good entry, whether it be a level platform at-grade, stair, ramp, or combination, must be protected from snowdrifting and melting snow sliding off roofs. It should also be well lighted and have a walking surface which allows snow, water, and grit to pass through before entering the building. Buildings may require a ramp for compliance with handicap code requirements for access. (See Section 1.20). With creative planning, the entry (and handicap) ramp can be designed to serve the building's major entry as access for people, supplies, and/or vocational shop projects. An open-grate entry ramp can effectively serve to clean snow, mud, and grit from shoes before entering the building. Openings in the grate must be 1/2 inch or less so they do not become a barrier for handicapped persons with canes or wheelchairs. Ramps and stairs can incorporate broad landings or platforms where appropriate to facilitate informal outdoor gatherings and be part of an outdoor playdeck. Open railings with more than 50% free area do not obstruct the passage of wind-driven snow, thus reducing snowdrifting problems. Entries, regardless of type, should provide a suitable "run" or length of open tread material to allow for grit or snow to fall off before entering the building.

8.81 Entry Vestibule: The entry vestibule provides transitional space between interior and exterior environments. The purpose of the vestibule is to reduce heat loss during entry and exit of people, and to form an airlock which minimizes cold air drafts and entry of snow and grit into occupied areas. Vestibules should be located at all exits and designed to be as snowdrift-free as possible. Prevailing winds at the site need to be examined for locating doors and selecting hardware so that doors are not blown open or become difficult to open and shut (whether published data indicates prevailing wind data or not, it is wise to ask local people about prevailing and storm winds). Access to all fire exits must be maintained regardless of drifting conditions. Careful placement and design of rails, overhangs over open stairs, drift tunnels, etc., can minimize both hazardous conditions and snow/ice removal costs.

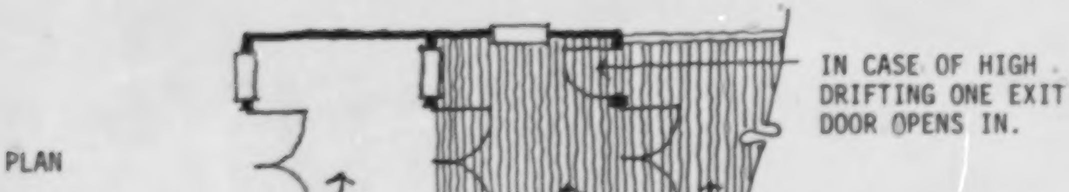
The vestibule requires enough travel length so the outside door will be closed before the inside door is opened (and vice versa). This cuts down on strong winds entering the building (which can blow open other doors) and minimizes heat loss.

Consideration should be given to multiple vestibules (discussion below) for principal entries and an additional outside inswinging door, in addition to the code required area of outswinging exit doors. Inswinging doors provide additional means of escape when unforeseen rapid drifting conditions occur which could prevent immediate access to and from the building before snow can be removed.


PLAN
ONE EXIT DOOR SWINGS IN.
HEATED
GRATE (NOTE: 1/2"MAXIMUM GRATE SPACING FOR HANDICAPPED.)
ABSORPTIVE SURFACE
SECTION

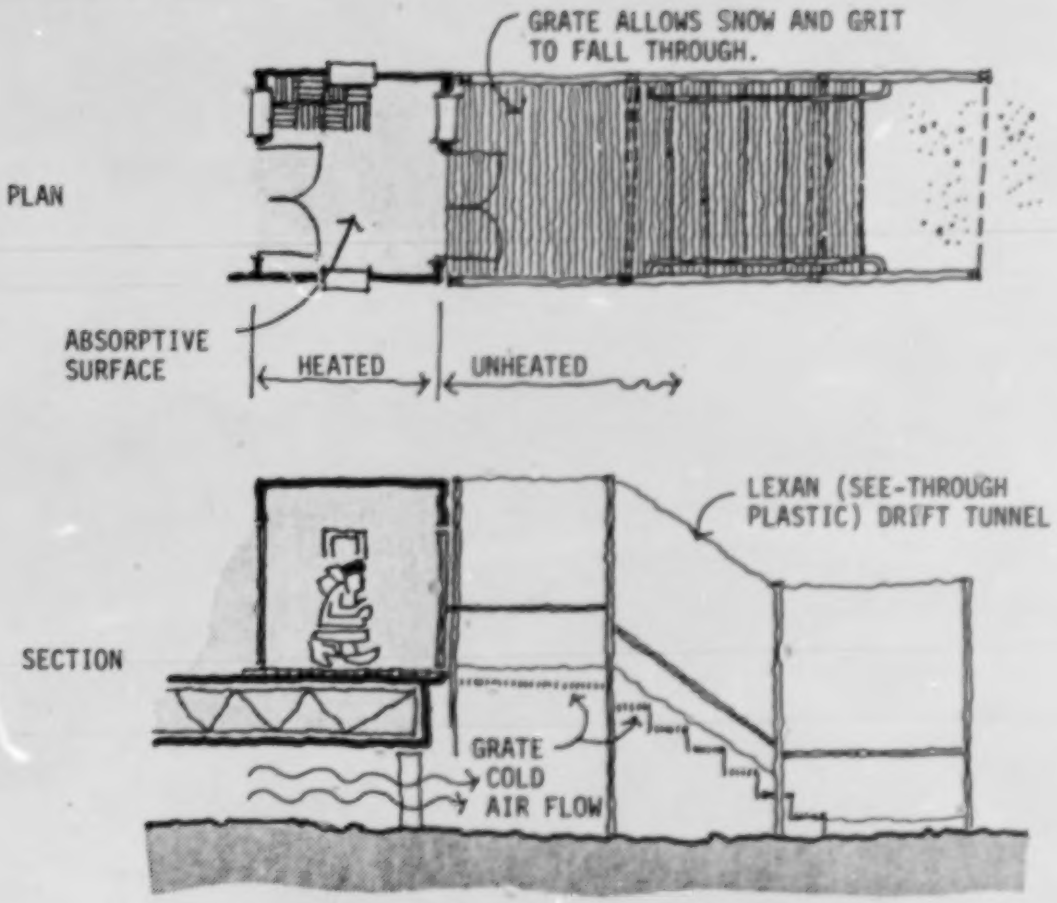
SINGLE VESTIBULE

(FIGURE 8.46)


PLAN
IN CASE OF HIGH DRIFTING ONE EXIT DOOR OPENS IN.
ABSORPTIVE SURFACE
HEATED
UNHEATED
GRATE ALLOWS SNOW AND GRIT TO FALL THROUGH.
ABSORPTIVE SURFACE
SECTION
GRATE
COLD AIR FLOW

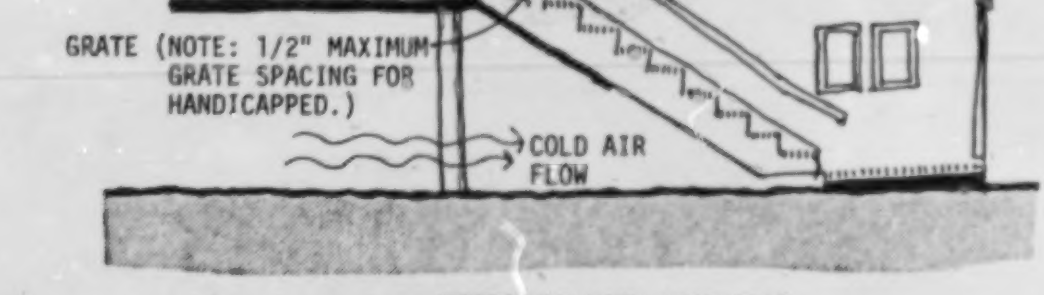
DOUBLE VESTIBULE

(FIGURE 8.47)


GRATE ALLOWS SNOW AND GRIT TO FALL THROUGH.
PLAN
ABSORPTIVE SURFACE
HEATED
UNHEATED
LEXAN (SEE-THROUGH PLASTIC) DRIFT TUNNEL
SECTION
GRATE
COLD AIR FLOW

VESTIBULE WITH DRIFT TUNNEL

(FIGURE 8.48)


SECTION
WARM AIR "TRAP"
GRATE (NOTE: 1/2" MAXIMUM GRATE SPACING FOR HANDICAPPED.)
COLD AIR FLOW

VESTIBULE WITH HEAT TRAP

(FIGURE 8.49)

8.811 Single Vestibule: The basic entry protection is a vestibule which is a heated transitional space with a floor surface suitable to clean snow, mud, and grit from shoes before a person enters the building. The minimum number of doors will be determined by code exiting requirements, but as mentioned previously, consideration should be given to an additional outswinging door. Also, protected glazing adjacent to, or in doors, provides visual information about the environment one is about to enter. (See Figure 8.46).

8.812 Double Vestibule: A double vestibule is ideal for heavy traffic entries, especially where wind, snow, and grit are problems. A double vestibule consists of two compartments: the innermost compartment is heated and has an absorbant floor surface; the outside compartment is unheated and has an open grate floor. The two compartments will reduce heat loss and wind problems, particularly when several people are using the entry simultaneously. The unheated compartment also allows a sheltered spot to adjust clothing before entering or leaving the building. (See Figure 8.47).

8.813 Vestibule with Drift Tunnels: A solution for entries in snowdrift locations which cannot be avoided is a drift tunnel. This provides a safe passage out of the drift area. (Snow fencing the site at entries is a last resort solution). (See Figure 8.48).

8.814 Vestibule With Heat Trap: This type of entry has an outside entrance below the building floor level. This can be physically accommodated when the building is elevated on piling. Ideal arctic entry for ambulatory persons. (See Figure 8.49).

1. Advantages:

   a. Reduces drafts and heat loss when inner doors are opened because when the outermost entry is below floor level, heavier outside air stays at the bottom, while lighter warm air from inside is trapped above.

2. Disadvantages:

   a. Enclosing a ramp for handicap code compliance within this type of vestibule would be expensive to build.

   b. Vestibule enclosure to ground level can interfere with wind scour requirements under the building (where applicable).

End of Section

9.0 Building Utilities Options

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SECTION 9.0 BUILDING UTILITIES

INTRODUCTION:

This section encompasses plumbing, heating, ventilation and electrical systems required for the building to function. Due to the remoteness and severe environment in which a rural school is sited, there is an order of importance to the building utilities which must be considered. Electricity is required for plumbing, heating and ventilation systems to operate. The most important utility that the electricity serves is the heating system; without the heating system working, the building is unusable. Without the ventilation and plumbing systems, the building is still usable to a large degree, though it creates an inconvenience to the users.

9.1 HEATING SYSTEMS:

9.11 Total Building Heating Load: The evolution of a heating system begins with the anticipated heating loads a building will encounter. The total building heating load is comprised of building envelope heat loss, heating required to provide tempered ventilation air, and heating required for domestic hot water. These three elements comprise the total building heating load, which can be met as individual loads or any combination thereof, and form the basis in concepting a heating system.

1. Heat Loss: This is a design determinant of mechanical design controlled by design option 8.0, Building Envelope and Structure, and design determinant 2.0, Environmental Determinants.

2. Ventilation Heating Load: This is another mechanical design determinant, controlled by design option 4.0, Building Program for Secondary Schools; and design determinants 1.0, Building Program Determinants, and 2.0, Environmental Determinants.

3. Domestic Hot Water Load: A mechanical design determinant controlled by 4.0, Building Program for Secondary Schools.

9.12 Heating Source:

9.121 Fuel: Diesel oil, wood and coal, or a combination, will be reviewed as the heating source for heat generation. Wood or coal as fuels will depend on local availability. (See also Figure 3-1).

Advantages:

1. Oil: Allows automatic operating heating system, low maintenance, on-site storage, clean burning.

2. Wood and Coal: Local availability, on-site storage, lowest operating cost.

Disadvantages:

1. Oil: Annual storage requirement, high cost.

2. Wood and Coal: Manual labor required, dirty burning, high maintenance, no automatic heating system.

9.122 "Waste Heat" Recovery: The availability or future probability of utilizing "waste heat" from an on-site or local power plant should be given strong consideration.

Advantages: Allows automatic operating system, low operating cost, low maintenance.

Disadvantages: High first cost, full sized backup heat generation required; depending upon source, more complex system.

9.123 Heat Generation:

1. Furnace: A furnace can be provided to use as a fuel oil, coal or wood or a combination. Most wood/coal furnaces, providing oil firing, use the oil firing as a standby fuel which automatically fires when the wood/coal section has not been refueled.

Advantages: Allows a simpler heating system than boilers, combines ventilation with heating on small systems, uses air which does not freeze.

Disadvantages: Zoning for thermostatic control only allows one thermostat for one furnace. Combination units require double the floor area of a single-fuel unit. Temperature of supply air will vary with multi-fuel units.

2. Boilers: A boiler system can be provided to generate hot water or steam, using fuel oil or coal.

Advantages: Allows multiple zoning from one boiler, requires less space, better temperature control of supply water.

Disadvantages: Steam or water can freeze, more complex than furnace.

3. Location: The location of the heat generating equipment is called a boiler room, a furnace room, or a mechanical equipment room, in which the major components of the heating system are located. It is, therefore, necessary that a maintenance work station be provided in or adjacent to this room. The work space should contain a workbench, storage cabinets, some basic tools, and a minimum supply of critical equipment items necessary for the operation of the heating system. This could include nozzles for the oil burner, filters for the oil burner (or perhaps even an additional oil burner), filters, a thermostat, a fuel oil pump, a hot water circulating pump, control valves, fan motors, and other parts of equipment required for electrical system and plumbing system. To reduce the maintenance headache, common sizes of equipment and common component sizes should be strongly considered in the design process to minimize different sizes of similar equipment.

9.13 System Medium:

9.131 Air: As a heating medium, air is superior to hydronic fluid because air does not freeze, air can be cleaned by filtration at a central source, and air can be humidified or dehumidified if necessary. Air is very adaptable as a heating medium in rural areas through the use of oil-fired furnaces, which allow the ventilation to be incorporated into the heating system in a very simple manner providing one zone with thermostatic temperature control.

Advantages: Not subject to freezing, cannot leak, less maintenance, air can be treated for temperature and humidity.

Disadvantages: Requires more space for installation.

9.132 Hydronic: This term indicates a hot water heating system with a sufficient antifreeze solution for protection of the system to design temperature when it fails. This basically requires a 50/50 glycol water solution suitable for a minimum operating boiler temperature of 200 degrees F.

A hydronics system has the ability, through a single heating source, to deliver the heating medium to terminal equipment which can form many heating zones. In addition, more BTU's can be distributed throughout the building system with less space requirement than a similar air system. A hydronics system cannot, by itself, provide ventilation as can an air system. In buildings requiring many zones of thermostatic control, a separate ventilation system is usually dependent on a hydronic heating system to provide tempering of the ventilation air.

Advantages: Requires less space, allows more zoning at minimum cost.

Disadvantages: Requires antifreeze solution, subject to leaks, requires separate ventilation system as hydronic cannot provide ventilation in a heating system.

9.133 Central versus Individual Heating Units:

1. Furnaces: Very adaptable as individual heating units because of single thermostat zone control. With individual heating units, the supply and return air ductwork is greatly reduced when compared to a large central furnace room. Small furnaces are designed and manufactured to allow "closet" installation with all components accessible from the front. Generally always used as individual heating units when more than one unit.

2. Boilers: As a heating generation system, boilers are used almost exclusively for central heating units in a building. The heating generation system is easily separate from the air handling equipment used for the ventilation system. More BTU's can be pumped through a pipe than can be pushed through a duct of similar size because of higher temperatures and greater velocities.

9.134 Terminal Equipment: Terminal equipment refers to equipment at the point at which the heated air is delivered into the occupied space. This would include grilles and registers, baseboard cabinet unit heaters, and similar equipment.

1. Function: Because of the difficulty in the rural areas of procuring replacement equipment due to normal wear and tear and vandalism, the selection of terminal equipment must be given very serious consideration for durability, simplicity, accessibility, to provide the required function for the life of the building.

2. Selection: The selection of the terminal equipment should emphasize standardization of the various components for the terminal equipment, including sizes of grilles and registers, sizes of unit heaters, sizes of cabinet unit heaters, etc.

Advantages: Lowest "life cycle" cost, lower maintenance.

Disadvantages: Higher initial cost.

9.135 Controls: Temperature controls for heating systems can be manual but in all probability should be automatic controls of line or low voltage electric for small systems with a minimum amount of zones. Larger systems incorporating many zones and complexity will require pneumatic-type automatic temperature control systems. In all probability, there is not a need to consider pneumatic temperature control systems for building in this report due to the complexity and sophistication of pneumatic controls; line voltage electric and low voltage electric are much more easily understood for maintenance purposes than pneumatic.

9.2 VENTILATION/COOLING SYSTEMS:

9.21 Ventilation Requirements:

9.211 Occupancy: The space requirements section of design options 4.0, Building Program for Secondary Schools, establishes the floor space needs, and the Uniform Building Code establishes the occupant loads for those floor space needs. The Uniform Building Code, as applied to the rural school, states that a mechanically operated ventilating system shall supply a minimum of 5 cubic feet per minute of outside air, with a total circulated air of not less than 15 cubic feet per minute per occupant in all portions of the building, and that such system shall be kept continuously in operation during the time the building is occupied. Ventilation as discussed here is that portion of supply air which comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space. The requirement of a minimum of 5 cfm of outside air per occupant is an acceptable minimum based on the current state of knowledge and acceptable practices related to air filtration, quota control, and environmental physiology.

9.212 Cooling: Cooling has been included with ventilation in this section because whenever a ventilation system is designed for odor and air contaminant control; control of temperature and/or humidity of that air provides for the cooling requirements for the building's occupants. For the nine-month school year period, the outside air temperature is suitable to provide any required cooling requirement within the building, with the ventilation system also being the cooling system; however, the code requirement of a minimum of 15 cfm per occupant is too low a quantity to get proper distribution without stratification, short circuiting of air, etc. The minimum acceptable quantity should be 20 cfm per occupant with consideration of a flow as high as 30 cfm per occupant, depending on the individual requirements of the various areas making up the building and the type of ventilation cooling system being designed.

9.213 Special Use: The intended use of space in a school often involves special uses not covered by Code. Recommendations as to good practice for ventilation of special use areas have been made by many organizations and have been established as standards. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) has #62-73, "Standards for Natural and Mechanical Ventilation." The American Conference of Governmental Industrial Hygienists publishes a manual of recommended practice, "Industrial Ventilation."

Special use ventilation controls odor and pollutants by exhausting air to outside and supplying tempered outside makeup air to the space. In rural Alaska, the cost of heating outside air for tempered makeup must be reduced to a minimum. This can be done by establishing acceptable quantities and methods of providing necessary ventilation. Science rooms should use "makeup" type fume hoods drawing makeup air from another area. Welding booths should use electrical precipitation fan-filter units, allowing 100% recirculation within the welding area. Wood shops should be designed to allow the dust collection system to return the air back to the space after removing dust and particles to an acceptable level.

9.22 Optimize Ventilation Quantities:

9.221 Ventilation Heating Load: On the basis of occupancy and special use, determine the heating load of the ventilation at winter design temperature.

9.222 Building Cooling Load: On the basis of occupancy, lighting, interior and solar loads, determine the cooling load of the building at summer design temperature.

9.223 Establish Exhaust Air Quantities: Determine the required exhaust air to operate constantly when the building is occupied and the maximum exhaust air is required by special use.

9.224 Optimize Ventilation Systems: Adjust ventilation quantities to meet occupancy requirements and summer cooling loads while maintaining fixed building exhaust air and responding to special-use ventilation requirements.

9.23 Zoning for Temperature Control: The function of a thermostat is to respond to the needs of the space by controlling the temperature (or quantity) of the air being delivered to the space. When a thermostat controls the temperature for a group of rooms (a zone), all rooms within the zone must have similar heating/cooling requirements or unacceptable temperatures will develop within the zone. As an illustration, all interior rooms should be zoned separately from perimeter rooms, because perimeter rooms respond to seasonal variations which interior rooms never encounter.

The decision on zoning for temperature control is a result of owner (user) requirements, available project budget, and consulting engineer's experience.

9.24 Future Expansion: A consideration for future expansion is a design determinant on the ventilation system requiring a defined allowance for future expansion. This determinant is established by the Owner (user) or project architect.

9.25 Ventilation Systems:

9.251 Operable Windows: The Uniform Building Code allows for natural ventilation with a means of operable exterior openings with an area of not less than 1/20 of the total floor area. Natural ventilation is defined as the movement of air into and out of a space through intentionally provided openings. In the past, this has been achieved by the use of operable windows to meet the natural ventilation requirement. Though in design this provides a method of meeting code and reduced first costs, in actual operation it is not effective because it is not used. This method is satisfactory for residences, but should be discouraged from use in rural schools. (See Section 7.7)

Advantages: Lower first cost, lower operating fuel cost.

Disadvantages: Not used in winter, infiltration of snow and dust from outside.

9.252 Combined Heat and Ventilation System: For a single temperature control, an air system that combines both heating and ventilation requirements is the simplest and most reliable system in rural areas. This type of system utilizes an oil-fired furnace with either a manually controlled or an automatic outside and return air damper combination before the heat exchanger; then the temperature at the heat exchanger is raised to provide the heating needs of the space. This type of system generally requires more fuel than a more sophisticated method of heating and ventilating.

Advantages: Simple, reliable, easily maintained, easily understood by maintenance personnel in rural areas. Provides heating and ventilation in a single system. Low initial cost on small buildings.

Disadvantages: One unit per temperature control zone, larger zones will have warm/cooler rooms than room containing thermostat.

9.253 Separate Heat and Ventilation Systems: The consideration of separate heating and ventilating systems is determined by the number of zones for thermostatic control, number of rooms per zone, requirement for future building expansion, location and size of mechanical equipment rooms, building envelope and structure. Generally, the larger the building, the more rooms required, the more zones required, the better temperature control required with small differentials of temperature expected. This can only be achieved with separate heating and ventilating systems. For maximum flexibility in zoning, the heating system would then be hydronic.

Advantages: Accurate room temperature control by heating system and ventilation system, maximum zoning, ventilation system shutdown when building unoccupied, easily expandable for future requirements, lower fuel and power operating costs.

Disadvantages: Higher first cost, more complex system for maintenance, more controls, more skill required in design and construction.

9.254 Exhaust Air Systems: Exhaust air is defined as air removed from a space and not reused. These types of systems are required for toilet rooms, locker rooms, showers, janitor closets, warming kitchens, full service kitchens, science rooms, paint rooms, wood shops, metal shops, auto shops, marine engine shops, etc. Though the air cannot be reused if not treated to provide fresh air, the heat in that air may be used to preheat the outside air brought in to replace the exhausted air. With the high operating energy costs associated with previous special-use exhaust air requirements, the newest standards for odor and fume control must be applied to reduce operating costs in new construction.

Advantages: Minimum exhaust air provides lowest operating cost.

Disadvantages: Minimum exhaust air provides higher first cost and more complex system.

9.3 PLUMBING:

9.31 Plumbing Fixture Requirements: The plumbing fixture requirements of the 1976 Uniform Building Code are covered in Section 805 and also by the 1976 Uniform Plumbing Code Appendix C, Minimum Plumbing Facilities. For elementary and secondary schools, Section 805 of the Uniform Building Code, 1976 Edition, should be followed for minimum plumbing facilities.

9.32 Water Supply - Potable and Nonpotable:

9.321 Central Pressurized System: Reference Section 5, Site Utilities, for water supplies to the building utility system.

Advantages: Simple and easily maintained system.

Disadvantages: Reliability of central system.

9.322 Hydropneumatic Tank System: A small rural school, in all probability, will require its own water supply system, incorporating a storage tank and a hydropneumatic tank system for pressurization. The location on very small installations would be within and be a part of the building utility system, while on larger buildings it may be in a separate well or pump house adjacent to the building. Please refer to Section 5, Site Utilities, for a discussion on this design option.

Advantages: Simple, reliable, easily understood pressurization system.

Disadvantages: Additional equipment to be maintained.

9.323 Materials and Installation: The choice of materials for the water supply system should be limited to galvanized steel pipe or copper tubing. The actual determination of which material is more desirable should be determined for the specific site and system. The use of plastics is not recommended except on a special project basis until the problems with plastic pipes have been resolved. The major problem is the extreme expansion/contraction characteristics which, unless the system is properly designed and installed, will pull the joints apart. With domestic hot water piping, there tends to be sag between the pipe hangers if the pipe is not properly hung and supported.

The installation of the water supply piping should be such that it is installed overhead in warm space and accessible for maintenance and for future building expansion.

Advantages: Metal piping provides higher reliability and less maintenance than plastic piping.

Disadvantages: Higher first cost in labor and material.

9.33 Waste System:

The design of the waste system for the building requires interaction with Section 6, Site Utilities, to provide an optimized system for function and cost. The design of the waste system will be controlled by the availability of water and the method of disposal of the waste water. (See Section 5.2)

9.331 Conventional Gravity: At sites with a normal quantity of water, a conventional gravity waste and vent system can be designed.

Advantages: Low first cost, low maintenance cost.

Disadvantages: Operating cost could be very high depending on cost/gallon of water wasted.

9.332 Black and Gray Water: At site locations with a low water supply and/or a high cost per gallon of water made available for consumption, a black/gray water system must be considered. The black water system would provide for the human waste and any waste from a garbage disposal unit. The gray water system would be a recirculating type utilizing lavatory, shower, sink and other water sources for operation in a nonpotable water system for serving water closets and urinals.

Advantages: Low water consumption, low overall operating cost.

Disadvantages: Higher first cost, more complex system.

9.333 Honey Bucket: For the site location with no water available, or not available at a reasonable cost, the use of "honey buckets" or outhouses will be considered. The waste disposal which can be separated into human waste for the honey bucket and a gray water gravity waste system requires coordination with Environmental Conservation for the site disposal.

Advantages: Lowest first cost and operating cost.

Disadvantages: Limited to small buildings and DEC approval.

9.334 Other Systems: There are other waste systems in operation in the rural areas of Alaska of rather new concepts and solutions to waste collection and disposal methods. These systems are currently being used and data collected on their performance and suitability.

The advantages and disadvantages of these waste systems must be evaluated for effectiveness, reliability, first costs, operating costs, and maintenance requirements.

1. Composting Toilets:

   a. Natural Composting: Clivus Multrum, Toa-Throne.

      Advantages: No water nor electrical power required; low maintenance; self-contained system.

Disadvantages: Large space requirement; best temperature 90 degrees F.; piped vent to outside required; humidity critical.

b. Electrically Operated: Humus, Ecolet, Biolet, Mull-Toa.

Advantages: Small space requirement; no water; self-contained system; can be "shut off" and allowed to go below freezing without problems; low maintenance.

Disadvantages: Requires electricity; plastic construction; not proven for public use; no USA manufacturer; piped vent to outside required; humidity critical.

2. Incinerating Toilets:

a. Electrically Operated: Incinolet, Destroilet.

Advantages: Small space requirement; no water; self-contained sysetm. Can go below freezing without problems; moderate maintenance; metal construction.

Disadvantages: Requires large amount of electricity; operates at high temperatures (1600 degrees F. ±); piped vent to outside required; timed cycle between usages.

b. Propane Operated: Destroilet.

Advantages: Small space requirement; no water; self-contained system; small use of electrical power; can go below freezing without problems; moderate maintenance; metal construction.

Disadvantages: Requires large amount of propane; operates at high temperatures (2100 degrees F. ±); piped vent to outside required; timed cycle between usages.

3. Aircraft Toilet Systems: Telsford, Monomatic.

Advantages: Small space requirement; small power demands; low water demand; ideal for mobile use.

Disadvantages: Requires holding tank and chemical treatment; plastic construction; subject to freezing; not a waste disposal system but a waste holding system.

4. Pneumatic Toilets: Microphor.

Advantages: Small space requirement; low water use (two quarts/flush ±); metal construction; uses conventional waste system.

Disadvantages: Requires compressed air system at 60 psi ±.

5. Vacuum Toilets: Envirovac.

Advantages: Small space requirement; low water use (three pints/flush ±); vitreous china; uses a 1/2 atmosphere vacuum waste system for smaller piping; not required to slope in direction of flow; no vent piping system required; adapts to black and gray water system design.

Disadvantages: Requires vacuum air system at 1/2 atmospheric (7-1/2 psi).

9.335 Plumbing Fixtures: The design of a building water and waste water system must include the total system, from water consumed by each fixture and methods of disposal to the cost of water and the method of supply. The selection of fixtures will include consideration of impact on life-cycle costs by water requirements, durability to withstand vandalism and abuse, and reliability for proper operation. Depending on the availability and cost of water, consideration will be given during design to conventional fixtures with low water use, special low water use fixtures, and no water type fixtures. Review 510, Building Safety and Health Requirements.

9.4 ELECTRICAL POWER: (See also Section 6.4).

9.41 General: Design of electrical systems for use in rural schools must place special emphasis on several considerations. First, electrical power is an expensive commodity and can easily cost ten times as much as in urban areas. At 30¢ per kilowatt hour, each two-tube fluorescent fixture can cost $45.00 per school year to operate. Obviously, all resistance heating appliances, e.g., space heaters, water heaters, cook stoves, etc., should be avoided.

Secondly, electrical systems should be simple and as foolproof as possible. Complicated, sophisticated controls and switching should be avoided. Automated systems can be expected to fail just when they are most needed. Service or replacement for automated systems usually requires help from outside.

Finally, commercial power is usually characterized by poor voltage regulation. Voltage-sensitive devices should be avoided. Motors might be oversized so as to run satisfactorily under low voltage conditions. Under-voltage relays or voltage regulators might be considered, although addition of such "jewelry" would violate the "keep it simple" principle.

9.42 On-Site Generation: On-site generation covers an entire range from small standby generators, just large enough to keep the building "alive" during outages of the commercial supply, to full-sized power plants designed to replace commercial power. The choice of type and size of on-site generation must take into account cost comparisons with commercial power and performance of the commercial power system.

9.421 Standby Generation: At the very least, provision should be made for a small, light-duty standby (not emergency) generating set to provide power for essential building loads. The purpose of this standby generating set is to keep building heating systems operating during extended loss of the normal power supply. "Essential" loads can be segregated onto a separate circuit breaker panel and a manual transfer switch provided to facilitate use of the standby generator.

If limited or full operation of the school is anticipated during use of the standby generator, other things must be considered. The generator should be permanently installed in a building separated from the school; otherwise, noise and vibration will almost surely interfere with school operation. A fuel supply for several days' operation should be provided; this capacity will depend on expected usage and ease of refilling. The generator set should have a "standby" rating sufficient for the anticipated load. A less expensive, light duty set may be perfectly adequate for standby operation where use is expected to be only a few days a year.

Start-up and transfer should be manual. Again, this is not an "emergency" generator, and automatic operation is not required.

9.422 100% On-Site Generation: High cost and/or unreliability of commercial power may make 100% on-site generation an attractive alternative to commercial power. An additional benefit is that some of the generator set's water-jacket heat may be used to supplement the school's heating system.

The main disadvantage of 100% on-site generation is first and higher maintenance costs. To be reliable, the generating plant should contain at least two sets capable of sustaining the school's daytime peak load, and at least one smaller set sized for night loads and standby requirements.

The generator building should be separated from the school buildings, and if possible, should be on the downwind side of the school. Manual transfer switches should be arranged so that only one generating set can be connected to the school at any time. Paralleling, although offering some cost-saving advantages, requires equipment and skills which are too complicated. Simple water-jacket heat recovery systems should be considered, but exhaust gas heat recovery is expensive, requires special attention, and is therefore not recommended.

Exhaust silencers should be of residential grade, and exhaust tailpipes should be directed straight up or away from the school.

At least three feet of clearance should be allowed around each set, and double doors should be provided on one side of the generator building to allow easy replacement of any set. Work space and a workbench are recommended. Storage for filters and common replacement parts should be provided.

A small "pot" type oil burning heater, not requiring electrical power for operation, should be provided for emergency heating of the generator building.

A day tank of 50 or 100 gallon capacity should be provided so that fuel drawn into the generator building will be warmed before it is used in the engines.

9.43 Building Service and Power Distribution:

9.431 Materials and Equipment: Service and power distribution equipment should be high quality, top-of-the-line equipment. It costs just as much to ship and install inferior equipment; the small savings in first cost does not compensate for possible failures later on.

Circuit breaker panelboards (not "load centers") should be of standard manufacture, obtainable through an in-State distributor; circuit breakers should be of the bolt-on type. Fuses should not be used for service or branch circuit overcurrent protection.

Disconnect and transfer switches should be heavy-duty rather than general duty.

Copper wire should be used throughout. The small savings from using aluminum conductors does not offset the possibility of malfunctions or fires due to poor terminations.

Convenience outlets and wall switches should be high quality, 20 amp rated.

Box covers for receptacle and wall switches should be stainless steel.

9.432 Metering: It is recommended that a kilowatt hour meter be installed on the main service, whether or not a meter is required to measure purchased power. This relatively inexpensive addition will give the owner information necessary for control of the use of electricity, and will also provide invaluable data when planning future additions.

9.433 Vapor Barrier Penetrations: Penetration of the building's vapor barrier should be avoided except where absolutely necessary. When penetration is unavoidable, a conduit seal must be installed on the warm side of the barrier within a few inches of the penetration. Specifications should include detailed instructions for repairing the vapor barrier at the penetration. No wiring should be installed in the building's exterior walls or in ceilings where interference with the vapor barrier is likely. Wiring at these places should be exposed and surface mounted.

9.434 Classrooms: Convenience outlets should be liberally situated so that few, if any, extension cords are required. Surface mounted, multioutlet assemblies with receptacles five feet on center are recommended. These assemblies should extend around the entire perimeter wall and over work counters.

9.435 Shops: Equipment selection for shop areas is seldom fixed at the time of design and is likely to change throughout the life of the facility. For this reason, the power distribution in the shop area must be flexible. A separate surface mounted circuit breaker panelboard, sub-fed from the main service panel, is recommended for the shop area. A surface mounted wireway, in which receptacles may be installed at any point, is recommended for installation around the shop perimeter. Several empty conduits should be installed between the shop panel and the wireway for future loads. Sections of wireway may also be installed on the ceiling to accommodate equipment in the center of the shop area.

For safety, a shunt-trip main breaker in the shop panel should be considered, with a "panic" button located in a convenient spot. With this feature, all power to shop equipment can be quickly turned off in an emergency.

9.436 Multipurpose Areas: Again, liberal numbers of receptacles are recommended, with spacing of no more than 10 feet around the perimeter walls.

9.437 Other Areas: Receptacles may not be desirable in restrooms where they may invite tampering. Where the owner requests receptacles in the restrooms, they should be GFI protected.

Receptacles should be installed at convenient locations in corridors, offices, equipment rooms, etc., as dictated by good design practices.

9.44 Lighting:

9.441 General: Lighting usually makes up 50% or more of the total building load of a rural school. The designer can exercise considerable control over a major portion of the electrical load by good design of the lighting system. The designer should design lighting to the minimum footcandle requirements, while using fixtures with the highest VCP (visual comfort probability) index and highest efficiency. Lighting should be reviewed in accordance with ASHRAE Standard 90.

9.442 Lamps: The fluorescent lamp is probably the most efficient, practical lighting source available for lighting the small, low bay spaces encountered in rural schools. General lighting should be designed using the 40 watt, 48" cool-white fluorescent lamp as a standard. While HO and VHO lamps may be more efficient for some areas, the use of a single lamp throughout the facility eases stocking and replacement problems.

Mercury vapor, metal halide, or high pressure sodium fixtures might be considered for use in the multipurpose area. However, in the smaller wattages (250 watts or less), mercury vapor fixtures are seldom more efficient than fluorescent fixtures. Metal halide and high pressure sodium are somewhat more efficient. All have several disadvantages when compared to fluorescent fixtures:

1. Higher first cost.
2. Higher brightness, which tends to be annoying and troublesome for some activities such as basketball.
3. Delayed restrike after a momentary power outage; some type of supplementary lighting should be used.
4. An additional lamp type would have to be stocked.
5. High pressure sodium has a warm yellow cast which some may find objectionable.

Use of incandescent fixtures should be avoided except in areas of infrequent use, e.g., closets, mechanical rooms, etc., and perhaps for special effects (spotlighting at stage areas, for example).

High-pressure sodium lamps should be used for exterior lighting. These highly efficient lamps will start in ambient temperatures of -60 degrees F. To reduce lamp inventories, no more than one or two sizes should be used.

9.443 Interior Finishes: Interior wall, ceiling and floor finishes should be considered part of the lighting system. These surfaces should be as light reflective as possible. Where darker surfaces are proposed, the owner should be given data showing the additional first and operating cost as a result of poorer reflective qualities.

9.444 Fixtures: High-quality fixtures for general lighting cost no more to ship to the site and install than do fixtures of lesser quality. Some of the cost difference between low and high quality fixtures may be offset by the fact that use of fixtures with better coefficients of utilization may reduce the number of fixtures required.

Fluorescent fixtures for multipurpose rooms and shops should be high-quality industrial types with metal reflectors and wire guards.

Fluorescent fixtures in restrooms, showers, etc., should be damp-location labeled, with vandalproof polycarbonate diffusers.

Exterior lighting fixtures should have vandalproof polycarbonate diffusers.

9.445 Switching: Switching should be provided for multilevel lighting in classrooms and multipurpose areas. Switching should be conveniently located so that the users are encouraged to turn off unneeded lighting.

Switching for corridor and restroom lighting should be located in an area accessible only to the teachers.

Exterior lighting should be controlled by a photoelectric relay, but an override switch should be included to allow manual control.

9.446 Diffusers: Fluorescent fixtures with diffusers should be specified to have full .125" thick acrylic diffusers with sharp ridges. Diffusers should be flat, standard size (1' x 4' or 2' x 4') in hinged metal frames. Wrap-around diffusers should be avoided because they are difficult to ship and store, and any particular style may become obsolete.

9.447 Exit and Emergency Lighting: Exit signs manufactured by American Atomics are recommended as a standard. These signs require no electrical power and have no battery or electrical circuitry whatsoever. The one drawback to their use is that at the end of their useful lifetime (about 10 years), they must be returned to the factory for proper disposal of the small amount of radioactive material contained within.

Since automatic-starting emergency generators are not recommended, emergency lighting must be battery powered. Individual self-contained units are recommended similar to the Tork 6501. This unit is a small 8" square unit that fits inconspicuously against a wall or ceiling. It has a vandalproof polycarbonate diffuser rather than individual lamp heads, as do other types. The unit may be obtained with nickel-cadmium batteries, but long life lead-acid are recommended. Some problems have been reported with the use of Ni-Cad batteries where power has been turned off for long periods of time; the emergency lighting batteries become completely discharged.

9.45 Communications:

9.451 General: Communications systems include intercoms, public address systems (P.A.), fire alarm systems, telephone, radio communication and TV systems, and clocks and classroom signaling. Most are provided at the owner's option, and the failure of any one of these (within the exception of the fire alarm system) would not greatly inhibit the use of the school. Again, simplicity and ruggedness should be prime considerations.

Electronic systems should be distributed and serviced by in-State firms. Service contracts should be solicited for the owner's consideration. Equipment should be located in areas not normally accessible to students, or should be enclosed in lockable cabinets. Even where radio, TV, or telephone systems do not exist, it is suggested that conduit stubouts (with the vapor barrier properly sealed around each), with both ends capped, be installed in an exterior wall in anticipation of a future requirement for these systems.

9.452 Intercom: The intercom amplifier should be solid state with individual station and all-call capability. Speakers should be recessed in interior walls with conveniently located answer back switches. Wiring in conduit is recommended. A capability of using tape and record player inputs should be considered.

9.453 Public Address System: A P.A. system for the multipurpose room may be desirable. Where possible, equipment should be located in a small lockable room adjacent to the multipurpose room. This will allow easy access to the equipment for use for dances and games. The P.A. amplifier should accept tape and record player inputs, as well as microphones. Microphone jacks should be provided at convenient locations in the multipurpose room. Speakers should be centrally located radiating horns. Although much more expensive than box type speakers, high-quality horns are the only way of assuring reasonable sound quality in areas of poor acoustical characteristics. Wiring in conduit is suggested.

9.454 Fire Alarm Systems: It is especially important that fire alarm systems be supported by an in-State distributor. Specifications should require installation and check-out by the supplier. A maintenance agreement would be desirable.

A Class A system for both detection and alarm circuits wired in conduit is recommended. (A Class A system remains fully operational even after a fault or break in wiring occurs).

Pull stations should be nonbreak glass type. Flashing red lights should be included with the interior horns to warn deaf persons. At least one rotating beacon should be placed on the outside of the building in addition to exterior horns. An alarm circuit to a teacher's or maintenance person's residence should be considered.

A long-life, maintenance-free, lead-acid (not Ni-Cad) standby battery should be included. The battery should be capable of at least 24 hours of standby followed by five minutes of full alarm operation.

Alarm horns should produce a sound distinctive from class bells or other signaling systems. A drill switch should be provided at the alarm panel.

The generator building should be included on a separate zone.

9.455 Telephone: Even where telephone service does not exist in a village, it is suggested that at least one outlet be located in an office with conduit stubbed outside for possible future use.

9.456 Radio Communications: Radio communication systems are in use at some sites and may be desired at others. At the minimum, conduit should be stubbed out through the roof for an antenna lead.

9.457 TV Systems: It is suggested that a conduit for a future MATV (Master Antenna Television) system be installed with an outlet in each classroom and the multipurpose room. Conduit for the antenna lead should be stubbed out to the outside of the building.

9.458 Clocks: AC operated and master clock systems are not recommended. Inexpensive battery operated clocks are available which are acceptably accurate and operate up to one year on a "C" size dry cell.

9.459 Classroom Signaling: Programmed classroom signaling is not recommended. Where the owner requests such a system, however, a backup battery capable of keeping the system on schedule for at least 24 hours is recommended. In lieu of a programmed system, a simple AC operated system with a pushbutton located in an office is recommended.

9.5 INTEGRATION OF EXISTING UTILITY SYSTEMS:

9.51 General: An important part of planning for new facilities is making an inventory of the systems at the existing facilities. Often, this part of the planning is overlooked or neglected due to lack of time or money for a field trip prior to design.

Systems integration should explore the possibility of extending and matching existing systems. The existing facility may have been planned for future extensions, for example, so that extension of heating, electrical, water, sewer, or communications systems may be possible without duplicating certain central equipment. Even if extension of an existing system is not practical, consideration should be given to matching systems so that maintenance and operation procedures will be similar and so that maintenance and spare parts inventories will be common to both.

9.52 Water System: Connection to existing water systems is discussed in Section 3.11, herein. The important points to consider when connecting to an existing community water system are the adequacy of system pressure and storage capabilities together with the willingness of the owners of the system to enter into an agreement with the school district to supply water. When connecting to an existing school system, the area of concern is narrowed to pressure and supply capabilities and quality. After these major questions are answered satisfactorily, the task will be reduced to designing a service connection that is adequate for flow needed and is properly installed with freeze protection and structural damage protection.

9.53 Waste Water System: Connection to existing waste water systems is discussed in Section 3.21, herein. As with the water system, the adequacy of the existing community system to handle the expected flow is the most important factor. Agreement between the system owner and the school district is also a requirement. When connecting to an existing school facility, the adequacy of the system is the principal determinant.

The adequacy of a community waste water disposal system will probably be determined by referring to the original design which, in most cases, would be by PHS. Adequacy includes size of treatment facilities, pipelines, and lift stations together with elevations, grades, depth of cover, and freeze protection. As-built drawings should be checked in the field for authenticity.

When connecting to existing school waste water facilities, similar factors are important. As-built plans are frequently not accurate or complete, and on-site inspections of existing facilities are essential.

9.54 Coordination With Other Utilities: Water and waste water piping must be planned together with other outside utilities such as oil piping, oil storage and electrical lines. The questions of which utility goes under or over other utilities, what separations are needed for safety or sanitation, and how they all fit in with roads, walkways, and structures should be answered early in the planning for school construction.

9.55 Power and On-Site Generation: Extension of existing power and standby generation to the new facility may be desirable if sufficient capacity exists. If the power is supplied by a utility, the school may realize savings from having a single metering point instead of two; combining loads on the on-site generation system may also improve efficiency of the on-site generator by increasing loads so that the generator operates at a more favorable point on its fuel curve. Of course, similar savings may be effected by reversing the intertie; i.e., feeding the existing facility from the new school's service.

If the existing utility system will serve the new facility and the utility is a three phase system, the new facility should always have a three phase system also, with carefully balanced loads. Connecting a single phase load, such as a school, to a small utility system will badly upset phase balance and result in large phase voltage differences, which are especially detrimental to motors.

9.56 Communications Systems: Of all communications systems, fire alarms should receive the greatest attention with respect to intertie. Whether or not interconnection is feasible, strong consideration should be given to specifying a system in type and manufacture to an existing system so that both systems could be serviced under the same maintenance agreement, for example, and replacement parts would be common. At the very least, alarm types should be the same for both facilities, whether bells or horns, so that alarm annunciation in the new facility will match the sound that users of the older facility are accustomed to.

Extension of other communications systems is less likely to be possible or desirable, but use of like systems in the new facility should be considered.

9.57 Lighting: Matching of fixture types and lamps offer obvious advantages in stocking replacements, if such a match will provide fixtures and lamps suitable for the new facility.

9.58 Heating and Ventilating: Extension of existing heating and ventilating systems to new facilities will rarely be practical unless expansion was planned into the capacity of the original system, and only if the new facility is physically connected to the old. However, consideration should be given to duplicating the existing system for the obvious advantages of simplifying training maintenance personnel and the possible interchange of maintenance supplies.

End of Section

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